Chapter 1

Ether

In Kipling's short story "Wireless," a young consumptive man is given a drink of chloric ether in a chemist's shop in which an experiment in radio transmission is to take place. The effects of the chemical ether and the waves being transmitted through the electromagnetic ether appear to combine to induce him to entranced automatic writing in which he seems to channel the words of the young Keats.[1]

The point of Kipling's story, as Steven Connor tells us, is to demonstrate the possibility of interference between the different registers of the ether: chemical, electromagnetic, poetic, and spiritual.[2] In the late nineteenth century, the cultural space designated as "the ether" was itself traversed, as Connor reminds us, by numerous undulations and wavelengths. And it is this tremulous territory that I wish to dwell on here. Just as ether was seen by nineteenth-century scientists to pervade all space, so too were notions of the ether pervasive in Victorian culture. This opening chapter tracks something of the local oscillations of these discussions in which ideas around the origins of matter were framed. The life-spaces investigated here concern William Fletcher Barrett (1844–1925), a professor of experimental physics at the Royal College of Science, Dublin, and George Francis Fitzgerald (1851–1901), a professor of natural and experimental philosophy at Trinity College, Dublin.

From Aristotle's ponderings on the fifth element or "quintessence" to Oliver Lodge's Victorian whirling ether machine, ideas of the ether lie behind, and make possible, some of the thinking about space that has become an integral part not just of science, but of geography and cultural studies too.[3] As Albert Einstein put it in 1929, "The ether was invented, penetrating every-

thing, filling the whole of space and was admitted as a new kind of matter. Thus it was overlooked that by this procedure space itself had been brought to life."[4] Nineteenth-century configurations of the ether gradually became more amenable to the idea that space might give up its passive role as a mere stage for physical events.

Conceiving ether as the matter of space, or space as a kind of matter, made the notion of space mutable and productive. Thus, the ether began to be endowed with a multitude of chemical, physical, physiological, and theological functions, all of which have been amply illustrated by Geoffrey Cantor and Michael J. S. Hodge's 1981 outline of the ethers' checkered history.[5] The wide conceptual scope of their project draws initially from metaphysical and philosophical concerns, and traces the idea of the ether as an active imponderable fluid from its Newtonian origins through to the second half of the eighteenth century. The role of ether in chemistry and physiology, conceived of not as fixed form or clear outline, but as a tremulous cloud of sensations and reflexes is discussed in detail, as is its theological significance. Other studies concentrate on accounts of the mathematical and physical models of ether developed in the nineteenth century, and the scientific problems that gave rise to them, thus building on the work of the ether historian Edmund Whittaker whose foundational study on the subject was published in 1951.[6]

As one commentator has pointed out, "The editors wisely did not fall into the trap of trying to impose a superficial unity on such diversity."[7] Instead, as Cantor and Hodge note in the introductory essay, their concern was "to use the history of this unruly family of concepts to raise and clarify general issues that any comprehensive analysis of those two centuries would have to recognise."[8] This serves to alert the reader to the broad nature of the many contexts and usages that drifted into thinking about the ether when considered as a wider cultural practice of thought, and it is this domain that I wish to enter here by asking how the location of a particular physicist mattered in terms of the way ether was interpreted.

In spite of a few dissenting voices, the ether was generally regarded as indispensable throughout much of late nineteenth-century physics. Questions were raised not around its existence, but around the nature of the substance and its interaction with matter, as well as the larger metaphysical concerns that surrounded it. The issue at stake, according to the historian of physics, Helge Kragh, was whether the ether was seen as the fundamental substratum out of which matter was built, or whether matter was a more fundamental ontological category of which the ether was just a special instance.[9] Whatever the belief, Iwan Morus explains that the ether contained the mechanism through which the grand doctrine of the conservation of energy operated and became

manifest. As a result, it became a compelling and authoritative explanatory tool that pervaded the scientific culture of the day. Although the ether was one of the major success stories of nineteenth-century science, within a couple of years of the century's end, the all-pervading substance was vanquished to the sidelines of physics, having been "revealed as a baroque fantasy, better fitted for the condescension of a new generation, than for any serious consideration on their part."[10] Although this chapter will intrude on the diverse terrains uncovered by Cantor and Hodge's book, the story here focuses specifically on the Dublin engagement with the ether episode during its apotheosis. It investigates the ways in which the differing locations of two city scientists in regard to ether research—whether inside or outside "establishment" parameters—influenced scientific debate.

This ether inquiry can be traced back to the Newtonian physics first taught at Trinity College Dublin in the early eighteenth century by Dr. Richard Helsham, Dean Swift's medical adviser and fellow of Trinity. Here, the course of lectures on natural philosophy presented by Helsham pondered on the problem of the stationary ether and the lack of any physical effect of the earth's motion through it.[11] Newton's dictate, in accounting for the planetary orbits in terms of laws of gravitation, meant that the very existence of the ether would disturb and retard the motion of the planets and comets. This paradox had long played on the minds of natural philosophers.

Over the next hundred years or so Trinity scholars continued to address the issue. James McCullagh (1809–47), a professor of natural and experimental philosophy, developed mathematical models for the ether but claimed that he had not succeeded in acquiring any definite mechanical conception, stating "one thing only I am persuaded of, that the constitution of the ether, if it ever be discovered, will be found to be quite different from anything that we are in the habit of conceiving, though at the same time very simple and very beautiful."[12] To comply with theoretical specifications, the mechanical qualities of the ether had to be fluid so as to fill space, but rigid enough to support the high frequency of light waves. It also had to be massless and without viscosity, otherwise it would visibly affect the orbits of planets. In addition, it had to be completely transparent, nondispersive, incompressible, and continuous at a very small scale. The Dublin mathematician Thomas Preston summed up the difficulties in 1895, when he claimed that the existence of the ether could be established only by the "intellect" rather than by direct sensory experience. Its connection with ordinary matter was "far from being settled by experiment" and there were "difficulties . . . in forming a consistent idea of its constitution and function."[13] Despite these problems, several attempts were made to draw analogies with unusual materials. Osborne Reynolds believed the ether might

have had granular properties like sand. Gabriel Stokes preferred the idea of a jelly or wax. One of William Thomson's models conceived the ether as a special kind of liquid foam.[14] By the late nineteenth century, Trinity scientists along with colleagues elsewhere had made such progress in describing elastic solids and fluids that they felt ready to construct a full theory of the ether, and the ensuing deliberations were intertwined with developments in the theory of heat and an understanding of light waves.[15]

What is more pertinent to the direction of this chapter, however, is the fact that in acknowledging the existence of the ether, physicists also had to acknowledge that it was unlike ordinary matter and would have to possess extraordinary physical properties such as quasi-immateriality, universality, continuity, and unity. This made it a particularly flexible resource, which, once given scientific sustenance, could also then become a useful tool for physicists who engaged in political or religious discourse. Richard Noakes has recently made the argument that it was these supposed properties of the hypothetical ether that made it a plausible argument against a determinist and materialist cosmology, a way of comprehending Divine intelligence and Providence, a mediator between terrestrial and spiritual existence as well as a metaphor of Tory views of the British Empire, socialist views of wealth, and the spirit of international cooperation.[16]

Noakes has deconstructed Brian Wynne's much-criticized vision of a coherent "Cambridge school" view of the ether, which embodied a substantial "Strong Program" thesis.[17] He finds fault with Wynne's implied cohesiveness of the scientific group, by highlighting instead the many unacknowledged diversities that existed regarding nationality, locality, religion, and social positioning of the physicists in question. Noakes thus guides ether historiography farther into the realms of geography, and it is here that I will continue the discussion by elaborating on the role of scientific *lives* in locating ether interpretations. William Fletcher Barrett and George Francis Fitzgerald had a significant influence on the progress of nineteenth-century physics.[18] Barrett was lauded for his work on the electrical, magnetic, and thermal properties of metals and for his studies on sensitive flames. Fitzgerald played a crucial role in the development of James Clerk Maxwell's theory of electromagnetism, and for instituting the Fitzgerald–Lorentz contraction, which later became an essential part of Einstein's theory of special relativity. Barrett, a non-Dubliner in Dublin from a nonconformist background, was based at the newly established Royal College of Science. He lived on the edge of the city. Fitzgerald was a professor at Trinity, a Dublin-born Anglican, and member of an elite circle of Dublin scientists centered around the university. His experiences of Dublin were very different from those of Barrett. To better understand the complex

relationship between these physicists and the cityscapes that circumscribed them, and to convey something of how their *lived* experiences in the city then directed them toward particular but different mobilizations of ether theories, the discussion now turns to investigate some of the Dublin spaces that informed the habitus of these scientists.

The Supernal Cityscapes of William Fletcher Barrett

William Barrett's view of the ether saw it more as a mode of sensitivity or susceptibility, a quasi-vital substance rather than a form of matter. Construed in this way, the ether could be deployed as a fundamental part of an argument for spiritualism. Physicists had radically diverging ideas of the ways in which religion mattered to the profile of physics in Victorian culture, and William Barrett was one of a number of new scientists who championed publicly the compatibility of physics and religion. A brief overview of that terrain here will serve to place his views in the context of contemporary religious conceptions of the ether.

For some religious physicists, the ether was useful for exposing the hollowness of materialism. Into this category would be placed those seeking to reaffirm their Christian faith and those looking for an alternative to Christianity, which they felt had been undermined by scientific naturalists. This group combined orthodox Christians, liberal Christians searching for scientific proof of religious experiences, and spiritualists, all of whom tended to be religiously motivated in their mobilization of the ether. This "persona" mobilized the ether primarily as a response to scientific materialism or naturalism, which many Victorian scientists with traditional Christian beliefs felt was a threat to their beliefs. Their fears were fueled by the publication of pure materialist dogma such as Ludwig Buchner's *Force and Matter* in 1855, and later by the implications of Darwin's compelling evidence in 1859 that all living things had developed from a few basic prototypes. The interpretations and responses to John Tyndall's controversial pronouncements of 1874 in his "Belfast Address," and the activities of the "X" club, were also pivotal in strengthening this view.

Scientists who upheld these beliefs found support in theories such as William Thomson's 1867 theory of oscillating vortex rings, the most important of a number of ideas proposing that matter itself might be a kind of convolution in the ether.[19] The ether thereby underwent an ontological promotion of sorts. No longer merely that which lay between things, it became, in the minds of some scholars, a primary matter out of which all things emerged. Following on from this, the Scottish physicists Balfour Stewart and Peter Guthrie Tait made the ether a central part of a religious argument in their 1875 book *The*

Unseen Universe, or Physical Speculations on a Future State: "We therefore welcome an hypothesis like that of Sir William Thompson, which regards the primordial atoms of the visible universe as vortices somehow produced in a pre-existing perfect fluid. . . . In the production of the atom from a perfect fluid we are driven at once to the unconditioned—The Great First Cause."[20]

Knotted vortices, according to Thomson's theory, constituted atoms. As a consequence of the work of Hermann von Helmholtz, once stamped in the "ether" at the moment of creation they would be eternal. One of the advantages of this view for the more religiously orthodox scientists like Barrett was that, although the stability of vortex rings in a frictionless medium would mean they would last eternally as atoms seemed to, they could not be regarded, for that very reason, as able to arise through some accident or evolution in the state of the ether; they required an act of precedent creation.[21]

Tait, a lifelong friend of Maxwell and collaborator of Sir William Thomson, held strong religious beliefs and with help from Balfour Stewart presented his case in *The Unseen Universe.* Their primary argument held that religion and the immortality of the soul were compatible with modern science: crucially, for scientists such as Barrett, *Unseen Universe* postulated parallel avenues of universes and described a world in which miracles and life after death were *scientifically* possible. A number of eminent scientists championed Tait and Stewart's alliance of physics and religion, but in quite different ways. For instance, Thomson's physical arguments against uniformitarianism had the theological consequence of defending the design argument against Darwinism, whereas Stokes directly employed both the design argument and biblical evidence—as reinforced by considerations of physics—to help deny the occurrence of evolution itself. [22]

Another slightly different approach was undertaken by the prominent Maxwellian, Oliver Lodge, who paved the way for Barrett. He sought to highlight the potential of physics to vanquish its materialistic image by focusing on how different ether was from ordinary matter. Lodge noted that there was a good chance that life and mind, hitherto excluded from the dynamics of matter in motion, could be accommodated "within a more general scheme of physical science."[23] Like Stokes, Lodge promulgated a universe permeated by life and mind through interpretations of ether physics and the notion of evolution "directed" by Divine agency, but he took a very different route from the traditionalist Stokes by building his mission on radical reinterpretations of Christian doctrines and appealing to the controversial results of psychical research. As Peter Bowler points out, the proponents of this view emerged as outspoken liberal Christians who challenged those aspects of Christianity that were deemed to be no longer compatible with the scientific worldview.[24]

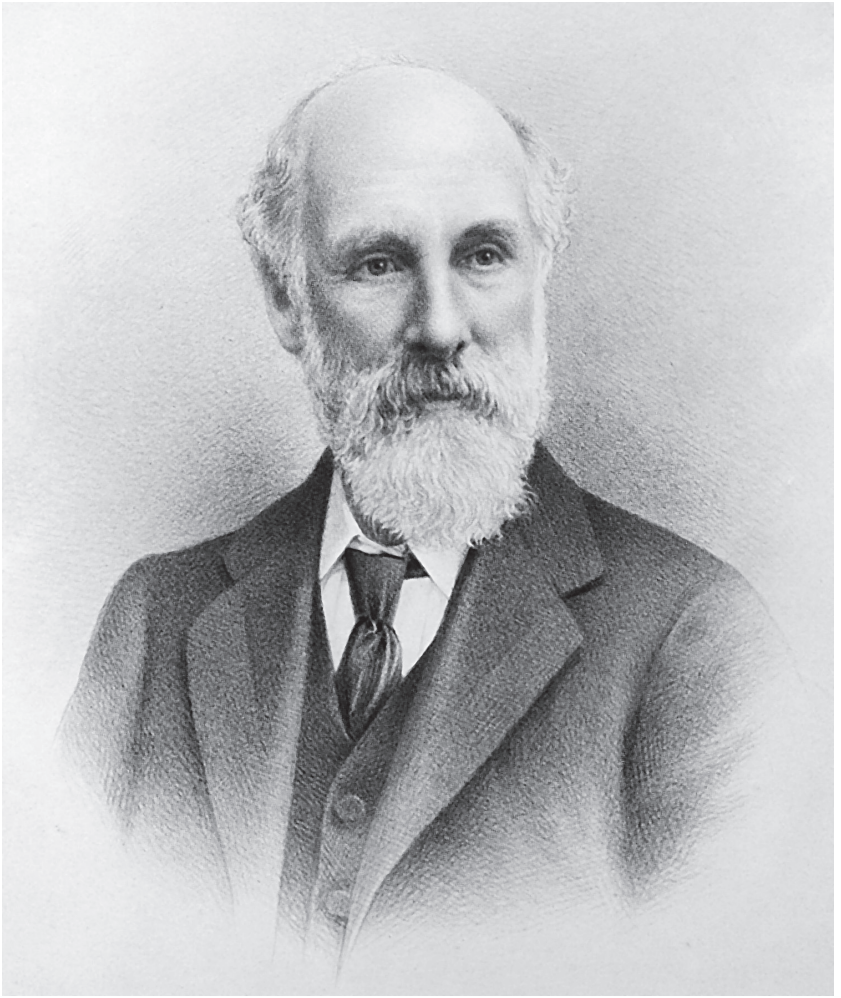

Figure 2. William Fletcher Barrett (1844–1925), professor of physics at the Royal College of Science for Ireland. Pencil portrait. Reproduced by kind permission of UCD Archives UCDA RCSI/215.

For them, it meant the liberalization of the Christian message rather than a rejection of it. As one of the main proponents of this new liberal Christianity, William Fletcher Barrett was an important figure in social and scientific circles in late Victorian Dublin.

He was a moderate home ruler, philanthropist, an advocate for women's education in science and medicine and a supporter of reforms in technical education. He corresponded regularly with Oliver Lodge and Balfour Stewart

while in Dublin, and one of his greatest friends and colleagues was Alfred Russel Wallace, who stayed with him on occasion in Kingstown.[25] Barrett was a founding member of the London Society for Psychical Research (SPR) and while employed as a professor of experimental physics at the Royal College of Science for Ireland, he stoked a burgeoning interest in psychical research among prominent members of the social and cultural elite in his adopted city, with the foundation in 1908 of the Dublin branch of the SPR. Despite his scientific and social standing, however, Barrett inhabited a peripheral location with respect to the conventional scientific community in 1870s Dublin. There exists no biography of this scientist, and unusually, no Royal Society obituary notice, and no biographical memoirs exist for him as a deceased Fellow.[26] He is primarily known today only in connection with the Society for Psychical Research.

Barrett's location on the fringes of acceptable science was made very clear at the British Association meeting in Glasgow in 1876, when Wallace invited him to speak to the Anthropological section. Barrett's paper on some phenomena associated with abnormal conditions of mind fueled ongoing debates, and some biologists, in particular Ray Lankester, attacked him for bringing the British Association into disrepute by "giving credence to a residuum of spiritual manifestations."[27] The peripheral publishing location of his work also weakened his reputation in the most important late Victorian scientific circles. Back in Dublin, his pro–Home Rule views—which asserted that "the solution to sectarian conflict was for all parties to experience the discipline of self-government" and be "forced to collaborate in a local legislature"—were setting him apart from the wider Unionist community."[28] This impartial stance was likely to have been inculcated in his domestic spaces where he enjoyed the nonsectarian politics of a suburban township where Catholics and Protestants often shared a middle-class social identity.[29] But Barrett despaired for the inner city, which he felt was enfeebled by the sectarian nature of politics, giving rise to situations that would be "incredible in England."[30] He found it to be inhabited by "dogmatic Protestants and Catholics who condemned all communion with spirits."[31] His nonconformist tendencies spilled over into the Society for Psychical Research as his psychical conclusions placed him increasingly at a distance from the elite of the SPR. While Barrett felt physicists were supremely qualified to investigate spiritualism, SPR members such as Henry Sidgewick and Frederick Myers were not convinced. Spiritualism with its history of associations with fraud was seen as the most dangerous area for scientific inquiry.

Some authors attribute his marginal influence on the history of science to the fact that he lacked many of the technical and social resources needed for

making a scientific career and had to build his reputation and social prominence through a series of teaching posts in new science colleges, through private research, and by writing articles for the periodical press. Although this certainly describes his career path, it was one followed by many Victorian physicists such as Tyndall and Lodge whose scientific lives have been well scrutinized. The following perusal of Barrett's life path and habitus will illuminate something of his "feeling for the game" of natural philosophy, and demonstrate the ways in which he was disposed to particular actions by the promptings of particular Dublin places.[32]

Barrett was born in Kingston, Jamaica, where his father, a Congregationalist minister and member of the London Missionary Society, ran a station for saving the souls of emancipated African slaves. As Alan Gauld tells us, Barrett's father, William Garland Barrett, seems to have been successful in instilling the virtues of Christian life in his children because two of his sons also became Congregational ministers and William himself, unlike many scientific colleagues, never experienced a crisis of faith, remaining a devout and earnest Christian all his life.[33] The family returned to England in 1848 and William attended Old Trafford Grammar School in Manchester before studying physics and chemistry at the Royal College of Chemistry, London. From 1863 until 1867 he worked at the Royal Institution, London, as an assistant to John Tyndall and came under the guidance of Thomas Huxley and Michael Faraday. A frequent visitor to the laboratory where he worked with Tyndall was the Royal Institution member and Irish physician, John Wilson, father of the astronomer Edward Wilson, who invited Barrett to spend summers at the family estate at Daramona in County Westmeath. Barrett describes his astonishment in discovering Wilson to be an investigator of animal mesmerism and describes some early attempts with the Wilsons to scientifically examine aspects of mesmerism on "a sensitive subject from the estate."[34] The results of these experiments had a profound effect on Barrett and heralded the beginning of his preoccupation with telepathy.

Interests such as these were not encouraged by his mentors back in London. The majority of Royal Institution scientists had by this time developed entrenched antispiritualist attitudes and sought to exclude what was considered illegitimate and deviant from scientific investigation. Previously, an article in *The Reader* in 1864 by Tyndall had launched a scathing attack on spiritualism, deriding all associated practices, and in a series of lectures and publications in the years that followed exploited the similarity of physics and spirituality to discredit the latter.[35]

This was not, however, the only area of contention between Barrett and Tyndall. In later years Oliver Lodge reminisced that "Barrett had been associ-

ated [with Tyndall] as an assistant in his early days, where he made the discovery of sensitive flames, though there was some subsequent soreness between Barrett and Tyndall about this discovery."[36] Mollan has unraveled something of the souring of the relationship between the two physicists during 1865 and 1866, a considerable part of which revolved around the publication of experimental results on sensitive flames.[37] After some further disagreements with Tyndall, Barrett eventually left the Royal Institution to teach at a number of other London Colleges, including the International College and the Royal School of Naval Architecture. By 1867 the fledgling interest in sensitive flames developed by Barrett earlier at the Royal Institution had blossomed into substantive research on the phenomenon, and in 1868 he journeyed to Dublin to deliver a lecture to the Royal Dublin Society.[38] Here, the *Irish Times* reported that Barrett captivated his audience with descriptions of a universe that was "ringing with noiseless music," and proceeded to conduct experiments and demonstrations of this effect for the gathered crowd. He went on to talk about "complex bodies capable of being thrown into an abnormal state," which were then "sensitive to the slightest stimuli if of the proper kind." This, the report claimed was what Barrett believed to be "the foundation for whatever truth there might be in the startling facts of mesmerism."[39]

Robert Ball, the professor of applied mathematics and mechanism at the newly established Royal College of Science in Dublin writing in later years remembered the "arresting lecture which he [Barrett] gave on this subject at the Royal Dublin Society" where he "dazzled his audience by making the 'wonderful' flame bob up and down in exact synchrony to the ticking of a distant watch."[40] It was largely through Ball's curiosity about the visiting lecturer's innovative research, that Barrett obtained his next appointment. In October 1873 Ball urged Barrett to apply for the chair of physics at the Royal College of Science for Ireland (RCSI). The RCSI in Dublin, on the recommendations of a commission headed by Lord Rosse had only recently opened its doors to students with the claim that "the object of the college should be to supply as far as practicable a complete course of instruction in science applicable to the Industrial Arts especially those which may be classed broadly under mining engineering and manufactures and to aid in the instruction of teachers for the local school of science."[41]

Tyndall and Huxley were particularly zealous in placing scientific men they regarded as allies in positions of influence at the new college to help spread the teachings of scientific reform and evolution. W. T. Thistleton Dyer, a former protégé of Huxley's, became a professor of botany at the Royal College in the early 1870s and Alfred Cort Haddon was to be recommended by him for the chair in zoology at the end of the decade. Likewise Tyndall, despite

recent wrangles with Barrett, supported his former assistant's move to the Royal College in a spirit of reforming zeal that aimed to establish the new scientific culture firmly in Dublin.

As these maneuverings indicate, the foundation of this Technical College in Dublin came at a time of intense debate about the teaching of science in Ireland. Whereas for Huxley, Tyndall, and their supporters in Dublin, Darwin's theory of evolution by natural selection outlined nearly a decade earlier had provided ample justification for the secularization of scientific education in the city, it was a different matter for the Irish Catholic hierarchy who viewed Darwinism as a threat to public morality. Calls to reform university education in a way that was sensitive to Catholics rang alarm bells in the minds of Darwinists, and scientific naturalists used their influence wherever possible to limit the influence of the Catholic bishops on scientific education.[42] Such was the evolutionary atmosphere that permeated the college building in St. Stephen's Green when Barrett arrived in 1873.

Darwin's theory had generated fault lines through Ireland's scientific community that initiated moves to define science once and for all. The varied doctrinal receptions of scientific naturalism in Ireland have been explored in detail elsewhere, but one pivotal event provides focus for all scholarship in the area, and this was John Tyndall's presidential address to the British Association for the Advancement of Science, in Belfast, which became an important nucleus around which science, religion, and education debates spun in Ireland after 1874. Barrett was just a year into his new post in Dublin when Tyndall's declarations were made.[43] Although the "Belfast Address" was uncompromising in its defense of the independence of the scientific enterprise, the specific Irish context for the 1874 pronouncements, and the careful qualifications of the kind of materialism he was promoting were lost in the furore that followed. In a later effort to clarify, Tyndall rejected the label of pure materialist in his own addenda to the published address, but was nevertheless interpreted as having promoted a pure materialism.[44] The reverberations of Tyndall's address were felt all over the island not just because of its inherently provocative aspects—the issues of Catholic restrictions on education, evolutionary biology, the promotion of materialism and determinism—but also because of misinterpretations of Tyndall's motives. The Catholic clergy complained that Tyndall's speech "had been carried by the periodical press into every town and village where there is a reading room or railway stall." Tyndall and Huxley were infiltrating Irish minds in the guise of, as Roger Luckhurst describes, "the Godless heads of a new intellectual order."[45] This association with materialism distanced religiously minded groups from even the outer spheres of certain scientific arenas. As David Livingstone demon-

strates, the tendency thereafter in Belfast Calvinist circles to define Darwinism in atheistic naturalistic terms denied compromises such as theistic evolution in certain quarters.[46] Similarly, Mark Wood has recently shown that the Catholic hierarchy held firmly to their belief in Tyndall's "materialism" as a tool to secure a particular kind of scientific education for Catholic students.[47] That, and their failure to secure a working system modeled on their own doctrines, for many years, resulted in an educational vacuum for Catholic students.

Barrett, therefore, found himself in a city, where on the one hand, technical education—which would be economically beneficial—was not available because of local politics. And on the other hand , the university system filled the city with "young barristers, clerks and others of that class" because it was "deemed degrading to enter anything that smacks of trade or handiwork" and "great sacrifices [were] made to put children to college where they will get what is called a profession." These were just some of the socioreligious cityscapes in Dublin that convinced Barrett that promoting science in Ireland was "most important to the country."[48]

He soon realized his mission as a technical educator by mobilizing all the resources of the Royal College of Science for Ireland to superimpose Tyndall's experimental culture of empire and industry onto an industrially underdeveloped Dublin. The lure of this new culture of experimental science manifest in a progressive new college, further sweetened by Robert Ball's promises that "the opportunities for original work seem to be very great," was enough to spark Barrett's sense of possibility and grasp this chance to popularize physics.[49] For him, the act of imparting useful technical skills was a wholesome pursuit, as it also served to inculcate moral values. Barrett's religious upbringing in the nonconformist tradition with its belief that virtuous acts on earth would be rewarded in a future life had shaped the nature of his teaching and anchored his habitus in such a way that carrying out civic duties in Dublin "went without saying."

Over the next few years Barrett was responsible for launching Dublin's first systematic classes in practical physics, constructing the Royal College of Science's first physical laboratories, effecting an overall growth in staff and students, and promoting physics to a subject in which students could graduate. The college gained a reputation for the excellent equipment of its laboratories and the emphasis on the practical teaching of science was deemed to be an inspiration to the rest of the country. Barrett's quick assimilation of contemporary scientific developments also played a major role in the broadening of the college's influence beyond simple teaching to the world of commerce, industry, and medicine.[50]

As well as his commitment to college duties, Barrett found time to carry out extensive experiments in his primary area of research: sound and vibration. During the 1870s in Dublin, he was commanding large audiences for his lectures on topics such as sensitive flames and glaciers, and in the public arena he was avidly promoting Huxley's image of the new science and admirably filling the role of Tyndall's protégé. In 1878 it was reported that "the science worship which is the religion of the hour, reached the pinnacle of its popularity last night in the conversazione" following Barrett's display of sensitive flames for delegates of the British Association meeting in Dublin.[51]

However, Barrett was also simultaneously carving out a niche that distanced him intellectually from his old teacher and his Royal Institution colleagues. As well as his formative experiences with mesmerism, Barrett's religious background had also provided him with the theistic space to allow dalliances with the spiritual; in his words, "Science reveals the garment of God, religion the heart of God . . . they are one in origin, and therefore in the progress of science we ought to see more clearly the existence of spiritual laws in the natural world."[52]

His continuing interest in matters spiritual led eventually to the setting up of the London Society for Psychical Research in 1882, the American Society for Psychical Research in 1885, and the Dublin Branch in 1908. The aim of these organizations was to make a systematic attempt to investigate debatable phenomena designated by terms such as "mesmeric," "psychical," and "spiritualistic" that amid "much allusion and deception" were "prima facie inexplicable on any generally recognised hypothesis and which if incontestably established would be of the highest possible value." Barrett contributed most to those areas of research that depended more on skills in experimenting on and isolating real-time effects, the kinds of effects encountered in physics laboratories. In Dublin, psychical research attracted mostly members of the social and cultural elite. In 1875 it was claimed that there were "more than twenty clergy men in Dublin, to say nothing of certain scientific and philosophical professors in connection with the leading scholastic establishments of Ireland, who are not only willing but anxious to investigate spiritualism."[53]

The Dublin branch of the SPR was an ethereal space of fashionable society, local intelligentsia, and Protestant free thinkers, described by one member as "a research group of intelligent, informed and highly placed men and women."[54] The organization worked hard to create a "respectable" scientific image and maintain that they were not "spiritualist" societies per se. Barrett's activities occasionally led to disagreements with members. His interests encompassed some of the many areas of what was castigated as pseudoscience and supernaturalism, being sidelined by the new generation of scientific nat-

uralists who, as we have seen, derided and discredited spiritualism and all associated practices.[55]

In 1875, two years into his Dublin post at the Royal College of Science in St. Stephen's Green, Barrett embarked on a review of three recently published books by well-known investigators of spiritualism, William Crookes, Alfred Russel Wallace and Asa Mahan, which was to appear in the *Nonconformist*, a little-known periodical of the time. The book review proved so popular that he was compelled to write an expanded version three weeks later. Although this was ostensibly a critical review, it served too as the platform from which Barrett launched his own views on spiritualism and specifically targeted what he also saw to be Tyndall's materialistic message the year before, and it is this latter aspect that interests me here. Because it was here that he mobilized the ether in order to bring together his disparate areas of physical and psychical research, and thus to mount an attack on materialism.

Barrett viewed the ether as a vehicle by which the universe could once more be seen as a *unified whole* following the advances of scientific naturalism. His was a "persona" disposed toward alleviating the woes of those "yearning for some deliverance from the meshes of materialism" and "groaning beneath a mechanical universe." Barrett, like Oliver Lodge, sought to bring the psychical and spiritual within the realms of physical science by underlining how different ether was from ordinary matter. As he explained, the ether illustrated the "transcendant unity of nature" whose true significance lay in the unifying Divine mind underlying such "material" links, and the ether seemed to have none of the imperfections associated with matter but had attributes of the Divine—that is, a perfect continuity and capacity to be the "universal connecting link" of the cosmos.[56] Because of his conviction that by using the latest techniques of experimental physics one could prove the independence of mind and body, the ether became particularly useful to Barrett in emphasizing the necessary connections between his physical and psychical research.

Although most controversies in the area of science and spiritualism were ostensibly disagreements over the reality of psychic phenomena, they were also conflicts over what kind of expertise was considered appropriate for investigating phenomena that were simultaneously physical and spiritual. On the face of it, Barrett's experimental methods and devotion to physics fitted well with the new order in science espoused by Tyndall and Huxley, but the psychical and spiritual meanings conveyed were "beyond the pale" as far as the "X" club savants were concerned. Ironically, it was Tyndall's experimental culture at the Royal Institution that played a major part in Barrett's construction of a science of mesmeric and spiritualistic phenomena.[57] Tyndall had trained Barrett on the use of numerous instruments and resources for

manifesting, manipulating, and measuring vibrations in the invisible ethereal medium that were often beyond the range of human vision. His work with Tyndall had developed an acute appreciation of synchrony, and in an issue of the *Quarterly Journal of Science* he expanded on analogies that Tyndall had drawn between light and sound, and between human organs of sense and musical instruments. This was a first step toward his later claim that human perception of light and sound was the result of "sympathetic vibration" between the acoustical and luminous waves and the fibers of the inner ear and the rods and cones of the eye. By the time he was ensconced in Dublin, Barrett made this branch of physics fulfill religious and spiritual functions and embarked on a quest to take Tyndall's methods in a new direction in his adopted city despite opposition from some quarters.[58]

While he was employed at the Royal College of Science, Barrett actively pursued the idea that telepathy might be comparable to physical systems exhibiting resonance. By the 1890s his article "Sympathetic Vibrations" in the Christian publication *Good Words* started with a survey of resonant phenomena in acoustics and concluded with the observation that sympathetic vibration was a principle that held for the invisible vibrations of the ether and supported "many obvious spiritual analogies."[59]

Barrett held that mesmeric and spiritualistic phenomena were puzzles that physicists could interpret and investigate more effectively than psychologists or physiologists. Because he felt that materialism posed a bigger threat to faith than spiritualism, it was important to him to apply proper investigation that could be used to discredit materialism and he fought hard to make psychical research a branch of physics. In his article for the *Nonconformist* Barrett explained in great detail that by using the latest techniques of experimental physics one could prove the independence of mind and body. This was of utmost importance, because he sensed that "in the hands of the superstitious, simply curious and ignorant, spiritualism was the path to moral derangement and impiety," but when it was conducted "in the spirit of an honest search for truth" and considered by "the dry light of science," it provided objective proof of "facts of transcendent importance," and a source for "stirring the potent conviction that there *is* a spiritual body."[60] In his RCSI lectures he espoused a connection between the physical and spiritual worlds and emphasized that research on phenomena manifest to the senses, whether glaciers, sensitive flames, or "spirit writing," showed the existence of spiritual laws in the natural world.

This tangential position was further underlined by the siting of his home base in Kingstown, where the physical distance from the coterie of scientists in the city left him beyond the bounds of the "cognitive topography" of Dub-

lin physics.[61] Added to this, Barrett's psychical interests were further ignited when James Wilson, the brother of his old colleague from Westmeath, became a neighbor in the coastal suburb. Throughout the 1870s he attended séances held in Wilson's home. Barrett also engaged in experiments here with the Lauders family, who under the name Lafayette, were spiritualists and leading photographers in late Victorian Dublin.[62] On his summer vacations, he made extensive investigations of dowsing in neighboring County Wicklow and published two book-length articles on water divining in the proceedings of the Society for Psychical Research in 1897 and 1900.[63]

We can now begin to see something of how Barrett's Dublin spaces actively encouraged and endorsed his particular understanding of the ether. Returning to the crucial tenet of his faith—that religion and the immortality of the soul were compatible with modern science—it becomes clear that he was strongly enabled by his Dublin locations to further develop the connections established in London between a little-known aspect of natural philosophy and an uncommon approach to the spiritual to underpin such a thesis. His research area of choice in physics—the study of "sympathetic vibrations"—was an obscure part of Victorian physical science, the results of which lacked consensus in the scientific community. Similarly, his reasoned "scientific" approach to the study of spirituality was unconventional. Located in the newly established Royal College of Science in Dublin, removed from the watchful eye of Tyndall and distanced from the natural philosophers at Trinity College, Barrett's borderline scientific endeavors flourished and his pedagogical mission to promote the spiritual and moral value of physics was uncurbed.

Barrett's dedication to teaching both day and evening students in Dublin reflected his strong belief that physics was the only way to revitalize faith in Christian spirituality and safeguard public morality. His educational role outside the Royal College of Science whether in lecture theaters, schools, or articles in popular magazines was also part of this mission to popularize the subject. To him, physics was a "means of *education*" rather than a mere "vehicle of instruction," and when properly taught it "educated individual judgement by training the senses to habits of accurate observation and the mind to clear and precise modes of thought."[64] In the 1870s his public role in Dublin, although similar to that enjoyed by Tyndall in London, projected a very different message. Barrett's popularizing zeal limited his standing in the emerging scientific societies, but it increased his power over public audiences to whom he wanted to promote the image that physics, because it revealed nature's mysteries, was a form of religion. This intellectual space was further bolstered in his attempts to build up a reputation by frequently publishing his findings in religious periodicals such as *Good Words*, the *Nonconformist*, and *Light*.

His time in Dublin therefore, which he described later in a letter to Oliver Lodge as "the most God forsaken spot on this earth," provided him with ample space to instill moral values as well as teach useful technical skills.[65] It was by showing that physics was full of mystery and wonder, not merely reductive and mechanical that he succeeded in emphasizing the role of the experimental physicist as spiritual educator. Dublin's urban poverty and social strife elicited some of his most impassioned outbursts. In despairing letters to colleagues, he spoke of the "bottomless misery and poverty of the infinite drinking classes," which he felt were caused in part by the brewers, distillers, and publicans whose commercial success won them seats in the House of Lords.[66] As "Barrett's Dublin" was a city in which urban poverty and social strife called out for salvation from the excesses of commercialism and materialism, he devoted himself to a range of worthy causes from ameliorating the conditions of the poor to suppressing religious intolerance. During his tenure at the Royal College, he also established a nonsectarian teetotal men's club, promoted free libraries, women's education, and temperance.

Viewing the city from the perspective of temperance halls, working men's clubs, and relief centers allowed Barrett to call on what he saw as the edifying qualities of physics to remedy social disharmony. The ether was vital to Barrett for bridging the physical and psychical worldview, and his understanding of the substance as "the primary instrument of the mind and the habitation of the soul" enabled him to fashion a scientific space where both physics and religion could reside. Ether physics therefore became part of his moral quest to improve the lives of Dubliners.

So we see that the spaces Barrett occupied in Dublin facilitated his passion for the intellectual, moral, and cultural importance of physics and led him to believe, unlike scientific naturalists and orthodox Christians, that spirituality played a part there. His peripheral locations in Dublin allowed a particular mobilization of the ether that helped to shape the institutional and pedagogical spaces around him, and in so doing, influenced the scientific culture of the early years of the RCSI in a manner that ran counter to the prevailing climate of science.

Mobilizing the Ether in George Francis Fitzgerald's Dublin

At the time of Barrett's publication in the *Nonconformist*, his colleague at Trinity was also contemplating the ether, but it would be another three years before a chance introduction would influence the course of his ponderings. In 1878 Dublin was the venue for the British Association meeting, and it was here that a visiting Oliver Lodge, soon to be a physics professor at the Univer-

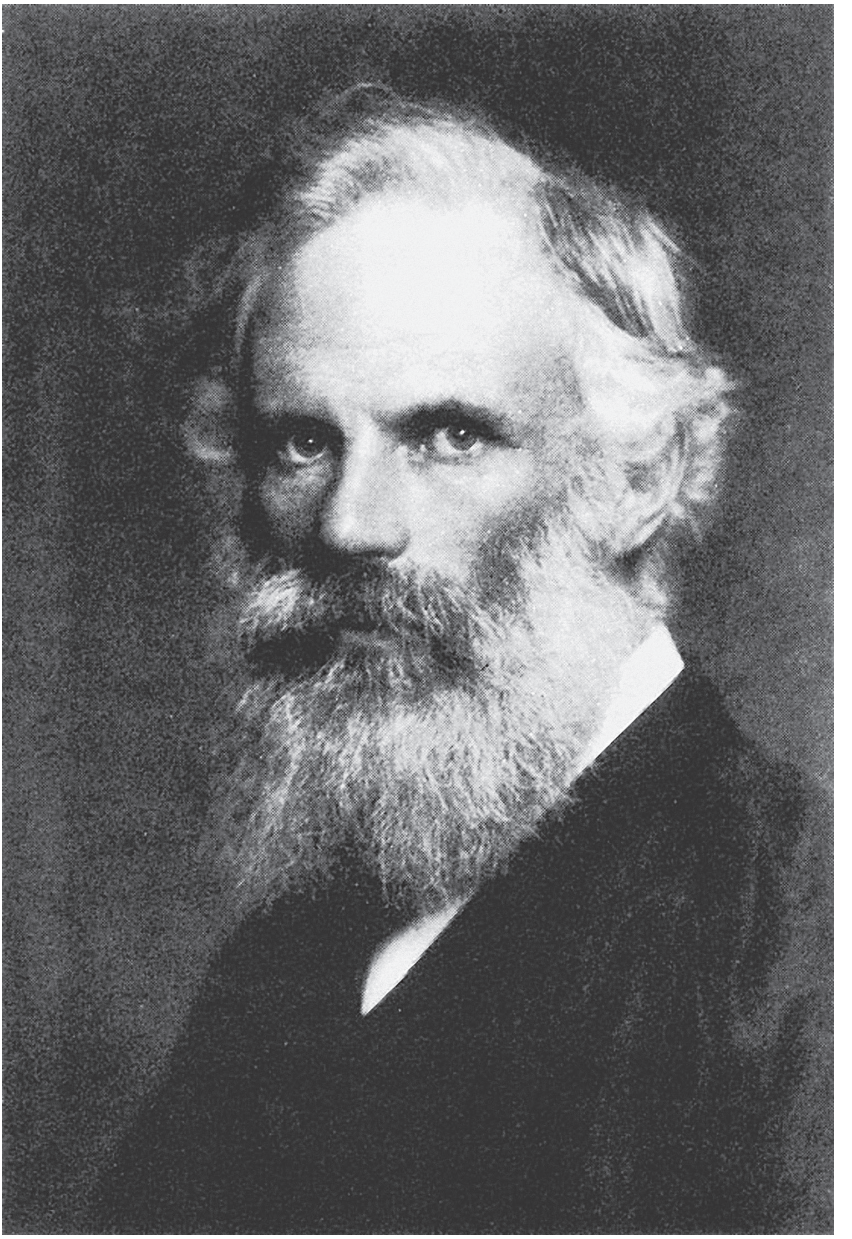

Figure 3. George Francis Fitzgerald (1851–1901), professor of natural philosophy at Trinity College Dublin. Wikimedia Commons: Public domain image.

sity of Liverpool, met the young Dublin physicist George Francis Fitzgerald. The two young men found they had much in common, including a shared enthusiasm for Maxwell's theory and a conviction that all electromagnetic phenomena could ultimately be traced to the strains and motions of the ether. They began an active correspondence and exchanged regular visits across the Irish sea, often meeting with other scientists such as Joseph Larmor, Heinrich Hertz, and Oliver Heaviside, and ultimately because of their shared interests, formed a group that later became known as "the Maxwellians." As their constant source of advice, encouragement, and bold ideas, Fitzgerald assumed the role of "St. Paul" among these "apostles of James Clerk Maxwell" according to Denis Weaire and Michael Coey.[67]

As a native son, a new man of science, and ardent Unionist, Fitzgerald's "Dublin" was, first and foremost, the second city of the British Empire.[68] He was an Anglican and member of the established Church of Ireland. Central to his vision for the advancement of science was the acknowledgment of this imperial status and the primacy of Trinity's place in it. Fitzgerald's eagerness to both encourage the economic benefits of the growing electrical, chemical, and telecommunications industry and secure Dublin's role as a venue for science can be best understood in the light of recent observations by the cultural historian of science Iwan Morus. Here, we are informed that "in civilisation, in industry and in the production of knowledge, 'progress' was the buzzword of the Victorian age."[69] And increasingly, during the late nineteenth century, science was tasked to harness nature's machinery in the name of this material progress. The attempt by late Victorian Liberal governments to grant Home Rule to Ireland was anathema to such views of imperial science. The proposal was seen by many as a potentially retrograde step that would undermine technological progress. It becomes increasingly apparent as we investigate the habitus of Fitzgerald, that the social and cultural capital (in the Bourdieuan sense) that formed his intellectual response was firmly rooted in the collective of scientists, outlined by Greta Jones who opposed Home Rule. A local Dublin counterculture influenced by Catholic hostility to the "Protestant modernisation" of science and Nationalist pressure over academic appointments was set to undermine this unified scientific elite. It was feared that because Irish science was sustained by the close relationships between British and Irish scientific communities, agitation of a Nationalistic hue would disrupt these scholarly relationships, to the detriment of Ireland.[70] My intention throughout is to probe the dynamic aspects of Fitzgerald's interacting political, religious, and intellectual spaces and reveal a habitus largely cultivated by ways of thinking that prioritized conceptions of unity and continuity over those of division and disjunction.

At the same time, as we have seen, Dublin scientists were contributing to the advance of natural knowledge in another important nineteenth-century arena. Here, it was ether physics that excited the imagination of scholars and provided the framework within which future progress in science would take place. To this end, Dublin's Royal College of Science has been disclosed as a space in which the "psychical and spiritual" could be brought within the realms of physical science, aided by Barrett's appeal to the differences between ether and ordinary matter. The chapter now turns to Trinity College Dublin and to a mobilization of the ether that strove instead, to underpin Protestant orthodoxy. In contrast, the focus here is on a scientific life that pursued connections between ether and matter.[71] For a start, Fitzgerald entertained the idea that the ether was a connecting link between the sciences themselves, thus blurring the spatial boundaries between empirical science and the workings of the "scientific system." He believed that the ether demanded "elucidation and strength," because without it, scientific disciplines were in danger of becoming too specialized and would suffer from "undernourishment" from other disciplines, and "local turgescence and inflammation would damage the whole scientific system." But Fitzgerald took this notion further in a revealing account of his thoughts on the subject of science and society published five years before his death. Here, he made a striking analogy between the corporate life of animals, social states, and the organization of the sciences where he argued that science was progressing in the same way as civilized states: "In general it needed intercommunication between its different disciplines, and in particular it required that research done in physical science be collected, digested and distributed to the biologist, chemist and geologist." The study of the "properties of each kind of matter as related to energy and the ether" was the most pressing aspect of this research because it had "bearings on every department of science and on every practice."[72]

Connections such as this one made by Fitzgerald between the ether, scientific disciplines, and social states have led Richard Noakes to suggest that Fitzgerald represents one of the few "plausible cases of a late Victorian physicist implicitly teasing out the social implications of the unifying capacity of the ether." Noakes's observation—that "corporate life" might have been a veiled reference to the union of Great Britain and Ireland that was the preserve of the conservative Cambridge elite of which he was a member—is intriguing. [73] By the 1890s, we know that Fitzgerald was fiercely opposing Home Rule and was only too aware of what he considered to be an undermining of the progress of a "civilised state," that is, the attempt by Nationalists to disengage with the British Empire. So we see that in tandem with Dublin's esteemed imperial position being threatened by Nationalist aspirations to disengage with Britain,

a general intellectual propensity to foreground notions of unity and cohesion emanated from Fitzgerald's scientific assertions on the ether. Whereas the substance—which was useful to Fitzgerald as a tool for supporting his belief in the unity of nature and the sciences—can be seen as a metaphor for his preferred polity as Richard Noakes outlines, my aim here is to approach from the counterpole and educe the extent to which tradition and ideas generated locally drifted into his scientific work.

Fitzgerald's preoccupation with this particular branch of physics, and his reluctance to accept the demise of the ether, I argue, was the manifestation of a specific Dublin habitus in which moves to accommodate modern science within the framework of Anglican theology were intrinsic. The quest to establish and underpin the natural links between "modern science" and Protestant culture was a vital component in strengthening the anti–Home Rule position. Fitzgerald therefore found in ether physics a crucial space in which to maintain a credible working relationship with scientific modernizers such as Tyndall and Huxley without forsaking the traditions of his Dublin Christian heritage, while at the same time reinforcing his anti–Home Rule message.

To explore these points the discussion congregates around three interconnecting but loosely sequenced themes. These introduce Fitzgerald's many Dublin lives; scrutinize his role as a scientific modernizer; and finally probe the essence of his anti–Home Rule stance. First, as a Dubliner, the *personal* stakes were far higher for Fitzgerald than other anti–Home Rule Unionist colleagues at Cambridge, such as James Prescott Joule, Lord Rayleigh, Balfour Stewart, Peter Guthrie Tait, and Joseph John Thompson. Any curtailment of the great imperial project by the establishment of an Irish Parliament, would mean the complete uprooting and expiration of his many Dublin "selves," as we shall see. Second, by investigating Fitzgerald "the physicist," as one of the new breed of late nineteenth-century "scientific modernisers," we can, by comparing his intellectual position with those of aggressively anti-Catholic "naturalist" colleagues such as Tyndall and Huxley, unearth something of the agency of his native city—particularly Trinity College—on certain tenets of natural philosophy that were fundamental to late Victorian ether theories, but were grounded in Christian theology of a Hibernian stripe.

Third, by acknowledging Iwan Morus's observation that physics at this time was the vehicle for the expression of deep fears about what the new century had to offer and Greta Jones's claim that the cause of scientific modernization and (Social) Darwinism were truly connected; it is my contention that further scrutiny of Fitzgerald's Dublin life-spaces allows for a better understanding of the depth of his feeling about the breakup of the Union in the context of contemporary fears; not just about the role of science in a post–Home

Rule Ireland, but also around the nineteenth-century concepts of progressive evolution and degeneration.[74] Reflecting along these lines brings Fitzgerald's fin-de-siècle ruminations on ether physics into sharper focus.

The elevation of physics as a scientific discipline and the widening of its authoritative jurisdiction were well under way in the 1890s. Its practitioners were viewed as rational modernizers who drove the all-important advances in technology. But the negotiating grounds on which scientific expertise and authority were debated had been appropriated by "X" club members, resulting in a conflation of "scientific modernism" and "naturalism." Ether physics, however, remained a compelling area of research for both theoretical and experimental endeavors in physics because it provided space for scientists like Fitzgerald who were not antiestablishment or antireligion to locate themselves within the modernist movement in science. For many of these more establishment and religious scientists, the notions of unification and progress were inseparable, and for them the ether can be seen as having evolved as an inevitable outcome of the human quest to understand the cosmos in a way that upheld Protestant traditions of both science and society.[75] For Anglicans such as Joseph Larmor, whose writings contained much historical analysis and many hagiographical accounts of Protestant ether builders, the ether symbolized the importance of traditional values over radical change in science and politics.[76] For Fitzgerald, however, this was far from a theoretical abstraction, He was, by contrast, *living* through political change and uncertainty. The immersion of his many Dublin personae in the changing political landscapes of Unionist Dublin, was I suggest, effectively reinforcing a traditional approach to his science. To illustrate this, it is first necessary to inspect his crucial relationship with the city.

Like Barrett, Fitzgerald believed that Irish society was in need of social reform and improvement, but his perspective was formulated through a very different lens. From a city perspective, and in sharp contrast to Barrett's peripheral status, Fitzgerald was a figure whose physical, intellectual, and social presence radiated from a central location. If we accept that scientific pronouncements are defined by reference to the positions—the moral and social spaces—from which they speak, then Fitzgerald's place in the city matters a good deal in trying to understand his mobilization of the ether.

His was a position of social and scientific authority in a city that was central to his adult life and work. Fitzgerald "the scholar" remained at Trinity from the age of sixteen until the end of his life, while others had left for posts abroad. He was immersed in a culture that was comfortable and familiar to him. The extended Fitzgerald family was embedded in the fabric of the college; his father and uncle were Trinity professors; and Fitzgerald was married

to Harriet Jellet, the daughter of the provost of Trinity. Their home at No.7 Ely Place, was a short stroll away from the college.

Outside the radiant rooms of Trinity, the grounds of the university were not simply the bounds of his workplace. On the greens of college park, Fitzgerald "the aeronaut" constructed, and was hauled skyward on a Lilienthal glider by his students. Nearby, Fitzgerald the "sportsman" practiced pole-vaulting and hockey and oversaw the affairs of the boat club. The performing Fitzgerald spent his evenings with eminent Dublin families of the time, such as the Jellets, the Stokeses, and the Jolys enjoying music and amateur dramatics in Dublin's Georgian drawing rooms.[77]

In his college, Fitzgerald was regarded as the "idol of the undergraduates and the hope of the older men."[78] Here, he also founded and became the most industrious member of the Dublin University Experimental Science Association, which met once a month to discuss and present new work over tea. On one of these occasions we are offered a rare contemporary glimpse of Fitzgerald's authoritative persona. A young Robert Lloyd Praeger reflecting on his time in Dublin in the early 1890s mentions that "the interest of those years was heightened by the existence of a little coterie of scientific men who met daily in a modest bun shop in Lincoln place opposite the gates of the college." As a junior member he was welcomed into the conclave, and described the activities of the group:

> [They] drank tea and devoured vast quantities of buttered toast and the discussion was on every subject within the confines of the universe—and sometimes outside them. Our leader and Chairman *honoris causa* was George Francis Fitzgerald, and around him were grouped W. J. Sollas, A. C. Haddon, Grenville Cole, Thomas Preston, Frederick Trouten, R. J. Moss and—John Joly would drop in occasionally, Sir William Ridgeway and Sir Joseph Larmor would join us if they were in Dublin. It was always a lively lunch table, the genial Fitzgerald essentially a product of Dublin and Dublin University, was a big bearded man, and his resonant voice filled the little room as he poured out wisdom and nonsense in a delightful medley—for he was a brilliant talker—often to the astonishment of customers at other tables.[79]

Commenting on the powerful influence of the new men of science in the late nineteenth century, the words of the economist and social reformer Beatrice Webb could well have applied to Fitzgerald when she observed, "Who will deny that the men of science were the leading British intellectuals of that period; that it was they who stood out as men of genius with international reputations; that it was they who were the self-confident militants of the period, that it was they who were rousing the theologians, confounding the mystics,

imposing their theories on philosophers, their inventions on capitalists, and their discoveries on medical men; while they were at the same time snubbing the artists, ignoring the poets, and even casting doubts on the capacity of the politicians."[80]

Fitzgerald epitomized this scientific persona or "creature of historical circumstance" alluded to by Webb that laid claim to cultural authority in the late Victorian era. [81] The power shift to these new men of science appeared in the 1870s with the emergence of an ideological "settlement" that grounded public assertions of science *outside* the compromises with church orthodoxy. The movement had its most forthright expression in the pronouncements of the London-based "X" club—a group of scientists who shared ideological commitments to "untrammelled science and liberal politics," and exploited connections with influential editors of the periodical press. These men became one of the most vocal and visible groups on the Victorian intellectual landscape and plotted an aggressive campaign to reclaim nature from theology and to place scientists at the head of English culture.[82] Ostensibly, Fitzgerald allied himself with this group. He joined with the new professionalizers in their attempts to promote science and technical instruction wherever possible, and like them, he upheld the moral and utilitarian benefits of such a training. He also attended meetings of the Physical Society of London, an organization that identified itself as a modernizing influence on science.[83] But the "naturalism" associated with the new movement was not embraced by Fitzgerald. In this respect he shared common ground with physicists Maxwell, Tait, and Thomson, characterized by Crosbie Smith as "the North British defenders of the faith."[84] Fitzgerald's relationship with the new science and its main proponents—such as his Irish colleague John Tyndall—was more nuanced, however, due to his particular location in Trinity, and deserves a brief outline here.

As Luckhurst outlines, scientific naturalism in colonizing the hitherto theological terrain laid claim to an increasing number of intellectual and institutional spaces as it progressed.[85] For instance, in the early 1870s Huxley became president of the Royal Society, and in 1874 Tyndall became president of the British Association for the Advancement of Science. In addition, Huxley's *Lay Sermons*, Tyndall's *Fragments of Science*, John Lubbock's *Origin of Civilisation*, and Edward Tylor's *Primitive Culture*, were foundational assertions, and along with Darwin's *Descent of Man*, these texts had a significant influence on intellectual culture of the late Victorian period. As Greta Jones observes, "The ethos of this scientific modernism was wrapped around the pill of scientific naturalism,"[86] and because in some circles this naturalism was conflated with materialism, Fitzgerald was tasked to find accommodation for his Anglican faith within the new science. However, by encroaching on previ-

ously theological terrain, the movement also opened up new space for debate within orthodox Christianity on the relationship between mind and matter. In Fitzgerald's own discipline of physics, the establishment of connecting links between ether and matter not only answered questions of science but also advanced wider societal concerns. The ether became the ultimate vindication of the new physics: "It was real because it could be manipulated—it could be made to do things."[87]

When Tyndall in 1871 reflected the scientific naturalists' view that the "foremost men of the age accept the ether not as a vague dream, but as a *real entity*, it was a substance endowed with inertia, and capable, in accordance with the established laws of motion, of imparting its thrill to other substances," he demonstrated the extent to which scientific naturalism *could* "embrace entities whose existence could not be empirically observed."[88] In fact, the new ethereal worldview was not incompatible with the preceding mechanical worldview, but it nonetheless differed from it by its emphasis on continuity rather than discreteness, and the corresponding primacy given to ether over matter.[89] In this respect, Fitzgerald and Tyndall had no argument.

In political terms, the adoption of the ether as an aid in befogging the boundaries between life and nonlife, and mind and matter, was propitious to the naturalists' aim of marginalizing the churches' role in scientific debate. To drive this message home, Tyndall's "Belfast Address" in 1874 was unambiguous in its support of a link between the law of the conservation of energy and evolutionary theory. Here both he and Fitzgerald began to diverge in their opinions. Tyndall preferred a disciplinary alignment quite different from that of Tait and Balfour, by using the ether to tether physics tightly with biology, before taking aim at the church. Because living things were subject to energy conservation the same as nonliving, the law helped Tyndall eradicate the distinction between life and nonlife. The law of the conservation of energy was, according to Tyndall, that which "binds nature fast in fate" to an "extent not hitherto recognized, exacting from every antecedent its equivalent consequent, from every consequent its equivalent antecedent, and bringing vital as well as physical phenomena under the dominion of that law of causal connection which, so far as the human understanding has yet pierced, asserts itself everywhere in nature."[90]

Although for Fitzgerald, there was no dualism between mind and matter and, like Tyndall, he envisaged the ether as a dynamic continuum, Tyndall's deterministic nebular hypothesis was a step too far for him. Fitzgerald believed that the complexity of the ether was insignificant compared with that of organic systems and held that the dynamic laws he believed completely described the ether were not arguments for biological determinism and materi-

alism. His friend and colleague Joseph Larmor summed it up by saying that "mechanical determinateness" need not involve "molecular determinateness" because the mechanical principles that were so useful for understanding the ether and other systems undergoing no structural change could not be employed to understand the molecular changes causing the origin and development of organic systems.[91] Fitzgerald's own language appears to be more dismissive of the materialistic element in evolutionary biology; he considered certain biologists to be "self-sufficient fools" for insisting that nature including human life had to follow fixed laws.[92] This term applied also to radical scientific naturalists in his own discipline of physics, and his arguments against materialism had their genesis in reaction to Tyndall's provocative Belfast pronouncements. The negative reaction to materialism was fast gathering pace in both scientific and public spheres, as a *Record* commentator had put it, "[Tyndall] accepts that the theory of evolution requires us to imagine not only that all the structures, animal and vegetable, were once potentially present in the fire mist of the nebulous theory, but also that all mental powers [all our philosophy, all our poetry, all our science, and all our art]—Plato, Shakespeare, Newton, and Raphael—are potential in the fires of the sun."[93] Despite presenting to the public a "radical mechanistic" persona who propounded "materialistic" summations of life's origins, Tyndall did not hold the view that all references to mental states merely described material events in the brain.

Several historians have discussed the new scientists' particular preoccupations with the spiritual and transcendental aspects of nature and, in particular, Tyndall's recognition that although the laws of matter and energy were the most reliable descriptions of the physical world, they were insufficient to answer profound questions such as the origins of life, force, and matter.[94] Even though Tyndall's mechanistic leanings suggest an origin in a broader idealist metaphysic, his mobilization of the ether as part of the nebular hypothesis to illustrate a deterministic version of "atomism"—in order to undermine church authority—was anathema to Fitzgerald, whose Dublin spaces buffered him from taking such a reductionist view.

Although other scientific naturalists such as Huxley had chosen empiricism over idealism, Fitzgerald's writings do reveal a position similar to that of Tyndall in which he sets scientific materialism in the larger context of natural supernaturalism.[95] But, whereas Tyndall found inspiration in the works of Thomas Carlyle and German Romantic writers such as Fichte and Goethe, Fitzgerald's idealism emerged from the older mathematical and Divinity traditions of Berkeleyan philosophy.[96] Fitzgerald makes clear that his interpretation of Berkeley provided fundamental metaphysical support for his contention that the physical world was reducible to pure motion. Bruce Hunt has

suggested that although Fitzgerald did not specifically connect the ether to metaphysical or religious questions, his attempts to reduce it to a form of pure motion in an incompressible fluid owed much to his belief that "following Bishop Berkeley, the cosmos reduced to forms of motion that were objective manifestations of a Divine thought."[97] Fitzgerald devised his vortex sponge model of the ether in 1885, inspired by Thomson's vortex mechanics and discussions with his uncle and the Trinity physicist George Johnstone Stoney.[98] Stoney had shared Berkeley's view that the world of phenomena, and the motion of the elemental ether in particular, was a manifestation of the thought of God. His belief that the "elemental ether was space itself, regarded as moveable" had helped Fitzgerald formulate his theory and underpin his contention that atoms might be stable vortex rings in a perfect liquid ether, making *matter* itself simply "a mode of motion" of the all-pervading ether.[99] Fitzgerald believed his model would be the greatest step "towards the comprehension of the intrinsic structure of the Universe which had been made since the time of Newton." It was hailed as a triumph initially by fellow Maxwellians. The success of the model was important for Fitzgerald because of his belief that there was a more fundamental level of reality beneath the laws of phenomena outlined by Newton and Maxwell.[100]

Fitzgerald referred to Berkeleyan philosophy in his Helmholtz Memorial lecture published in 1896 but had already outlined his thoughts quite succinctly in an 1890 lecture to the Royal Institution, where he made a more explicit connection with his vortex sponge theory: "This hypothesis explains the difference in nature as differences of motion. If it be true, ether, matter, gold, air, wood, brains are but different motions. Where alone we can know what motion in itself is—that is, in our own brains—we *know* nothing but thought. Can we resist the conclusion that all motion is thought?"[101] The fact that these elements of Berkeleyan philosophy permeate Fitzgerald's explanations of the ether can be attributed directly to his location at Trinity College Dublin.

The philosophies of Berkeley, himself a graduate of the university and member of the Anglo-Irish tradition, had a lasting legacy on Anglican thought emanating from Dublin's oldest university. With a name meaning "holy and undivided," and founded in a dissolved monastery, Trinity College was a major center for religious education, and the presence among its fellows of many clergy meant the established religion of the Anglican Church was never far from the mind of Fitzgerald and other late nineteenth-century Trinity practitioners. A sense of the enduring admiration for George Berkeley circulating in the college's corridors of physics emerges from a foundational piece on idealism published in 1872 by Fitzgerald's colleague, William Graham. In his essay, Graham claimed that the philosophy of George Berkeley was the only hope for

the future spiritual life of humanity because Berkeley offered the most complete antidote to these new "theoretical debasers of the human spirit," and he went on to claim that "materialism debases the human spirit because it makes thought itself a function of the brain and treats the human being as nothing more than a highly elaborated physical organism." In Graham's view, Darwinism was the most pressing variety of materialism in the 1870s, as it tried to "trace an unbroken continuity from protoplasm to man, from chemical action to the energy of the soul, even filling up the gap that was assumed to exist between vegetable and animal life." He despaired because he was sure that a spiritual life worthy of the name "cannot flourish in a materialistic ethos," and emphasized that for the idealist, it is not physical matter but consciousness that is the most important thing.[102] Finally, commenting on the legacy of the philosopher, he states that "for Berkeley, conscious intelligence, either subjective or Divine was from the beginning, is, and ever must be the Universe."[103]

It is evident too that friends of Fitzgerald in the Divinity School, such as Charles Frederick D'Arcy (later Archbishop of Dublin), were led toward these idealist philosophies as a bulwark against the materialistic interpretations of Huxley and Spencer. As D'Arcy tells us, "I felt a strong desire to know why distinguished men of science could no longer believe" and "Huxley, Tyndall and Spencer were the names that excited most horror among the orthodox." In the same publication D'Arcy also reveals the influence of Tyndall's challenge to established views and underpins the extent to which Berkeley's philosophy had infiltrated the Trinity viewpoint: "As I followed his [Spencer's] efforts to exhibit the process of the universe as a great evolution, I began to discern the nature of the problem which had to be faced. Tyndall's Belfast address was, however a more direct challenge; and I remember how I turned to Lange's *History of Materialism* to get some light upon it. Then it was that there came back to me the vision of Berkeley's philosophy which I had got in my early youth, and I was able to see how to meet materialism."[104] The mathematical and physical science departments to which Fitzgerald was affiliated had close ties with the Divinity School. Charles Frederick D'Arcy was well acquainted with the physical scientists, and mentions in his autobiography that "among the young men who impressed me were especially Fred Purser and George Fitzgerald, the researches of the latter it has proved led the way towards the new Doctrine of Relativity." R. H. Murray recalls also how J. B. Bernard and George Fitzgerald were always on "friendly terms," they had "mathematical and experimental science tastes in common, and they both manifested a lifelong reverence for the philosophy of Bishop Berkeley."[105]

In the late nineteenth century as contemporaries of Fitzgerald such as the mathematician George Salmon were making bold statements by abandoning

geometry for theology in what appeared to be a growing confrontation between the new science and religious belief, Fitzgerald was less conspicuous in his religious convictions. But in 1901, J. B. Bernard, in preaching the physicists funeral sermon, threw some light on the matter: "He would not divorce knowledge from life, for he knew full well the imperfection of our best attempts at theory. George Fitzgerald was a deeply religious man, though he did not speak much in public about religion. He knew as much as anyone of the secrets of nature: he did not waver in his belief that nature is ordered by one whose way is in the sea and whose path is in the great waters, though his footsteps are not known." And Bernard continued: "Do not speak to me of natural and supernatural, he said once, there is no difference really. You must not seem to banish God from nature."[106] Fitzgerald's reluctance to be drawn on matters religious reflects the problematic space he inhabited between the mores of Protestant theology, and the pantheistic ideologies of scientific modernizers like Tyndall. Unlike these "quasi-secularists" who were attempting to disengage from the church, Fitzgerald sought to strengthen connections between the Anglican establishment in Dublin and the "new science." Apprehending the situation from a spatial perspective, we can appreciate more fully how the flexibility of the ether—in advancing idealistic viewpoints of varying shades—made it an important scientific refuge for Fitzgerald. As a consequence, his vision of Dublin as a technological Utopia, generated by a merger of Protestant culture and modern science, became synonymous with both his anti–Home Rule stance and the survival of the ether concept.

However, by the 1880s there were indications that the ether concept was becoming scientifically untenable. The American physicist Albert Michelson and a colleague had devised a number of experiments to test Maxwell's suggestion that should the ether exist, then it would be expected to exert a drag on the earth as it moved through ether-filled space. There was no evidence of such a drag and the experiments eventually were deemed to have rendered the ether defunct.[107] In 1889 Fitzgerald was, however, still attempting to reconcile his ether theory with Michelson–Morley's null result, as is clear from a paper submitted to the American journal *Science*, in which he states: "I have read with much interest Messrs Michelson and Morley's wonderfully delicate experiment. . . . Their result seems opposed to other experiments showing that the ether in the air can be carried along only to an inappreciable extent. I would suggest that almost the only hypothesis that can reconcile this opposition is that the length of the material body changes, according as they are moving through the ether or across it."[108] This now famous paper was the impetus for the "Fitzgerald–Lorentz" contraction, which foreshadowed Einstein's thoughts in a 1905 paper titled "The Electromagnetic Properties of Moving

Bodies," in which he introduced the concept of special relativity. Fitzgerald's primary motivation in 1889 was the resuscitation of the ether principle, but by this date various errors and oversights had been found in his formulations, and the sponge theory was deemed unstable by his peers. As Lodge described, "At present the vortex theory of the ether labours under a great many difficulties . . . for it threatens to gradually change its properties with time, containing within itself the seeds of its own entanglement."[109] In 1890, Fitzgerald once again attempted to salvage his theory at the British Association Meeting. Here he demonstrated ways in which the tendency to instability could be delayed and that "the break-up of the sponge would in fact tend to become slower and slower." For the rest of the decade until his untimely death in 1901, he continued to advocate the vortex sponge theory refusing to admit defeat, as he confided to Oliver Heaviside, "I have a sort of feeling in my bones it must be so."[110] The theory thus persisted in his mind as the ideal of what a future unified theory of matter and ether should look like.

The vortex sponge model of the ether was a particularly seductive hypothesis as it offered a theory of the universe that was complete, unified, and fundamentally simple, and it thus remained a methodological guiding principle for many fin-de-siècle physicists.[111] In Dublin, Fitzgerald's reluctance to accept the demise of the ether can be seen in the context of an undermining of what he perceived to be the natural links between modern science and Protestant culture. Dublin physicists based at Trinity College seemed particularly eager to keep the notion alive. Fitzgerald's student and later assistant, Frederick Trouton continued to experiment on the ether until 1908. And as late as 1914, Trouton, who was then president of the mathematics and physical sciences section of the British Association, opened his address with a nostalgic reflection on the golden days of Fitzgerald. He reminded his audience that the principle of relativity "would not have been accepted half a century ago, when a purely dynamical basis was expected for a full explanation of all phenomena" and, he continued, "the men of that generation were the sturdy Protestants of science, to use an analogy, while we of the present day are much more Catholic in our scientific beliefs."[112]

To recap, then, Dublin's elite Protestant scientific community was at odds both with the secularizing professional classes modernizing science in London and with Nationalist scientific philosophies closer to home. Returning now to Fitzgerald's Dublin habitus, the remainder of the chapter airs something of the tensions arising from the shared city spaces that resulted in Fitzgerald's disposition toward establishment traditions over radical change in science and politics. Fitzgerald's problems in promoting science and technology in a predominantly Nationalist city were manifold. First, resistance to any changes

propounded by a "self-professed new scientific elite" was strongest among the Catholic hierarchy, who traditionally directed the course of education of their flocks. For their part, and spurred on by the "materialistic" pronouncements of Tyndall, the bishops believed that were it not for their own vigilance, an unbelieving tide would have swept through the entire curriculum. This circumstance justified "to the full the determination of Catholic Ireland not to allow her young men to frequent Universities and Colleges where bishops rebuked the indifference of those who may be tempted to grow slack in the struggle for a Catholic system of education."[113]

Second, Fitzgerald's involvement with a number of government commissions on education left him unhappy with the level of commitment to science that he experienced from administrators. Both he and Barrett played a role in the foundation of the city's first technical colleges and were members of the Provisional Committee assembled in 1887 for the Technical School in Kevin Street, Dublin. An Irish Technical Education Association was founded shortly afterward in 1890 to press for the provision of proper facilities throughout the country.[114] The correspondence between Fitzgerald and Barrett relating to the setting up of the Irish Technical Educational Association, reveals something of the tortuous process involved in this small step toward the provision of technological training in Ireland. Barrett, surmising that the views of this charismatic local scientist would carry weight in London, persuaded Fitzgerald to become involved, despite continued resistance to the plans among educational bodies closer to home. Resigned to a slow pace of change, he admitted to Fitzgerald, "If you knew the inner workings of the present system you would be amazed at its irritating ineptitude and that any educational institution over here could survive the disregard of local opinion that has universally characterised it—an installment of reform is better than none at all and one step leads to another."[115]

As well as sitting on the Board of Technical Instruction, Fitzgerald went on to work as a commissioner for education with the Boards of National Education and Intermediate Education to promote scientific education at all levels of instruction. However, by 1893 his frustrations with the system were still very much in evidence, as can be seen in his correspondence with the boards. In one letter, he laid out his views on the subject of primary school readers and registered his dissatisfaction with the textbooks passed by the board for use in schools. He complained that his attempts to get some readers rewritten were thwarted, and sections that he wished to include had been omitted "because a few sentences have been objected to by Trade Unionists and by Archbishop Walsh."[116]

Finally, his place of employment, Trinity College, found it hard to generate funds for science, a situation that was bound to get worse with the breakup

of the Union. Also, any technological aspirations on the part of the science departments were constrained by the perseverance of established academic traditions at the college. Despite being the first of the older universities to attempt to combine engineering with the more traditional liberal arts education, opening its engineering school and courses in experimental science in 1841, the courses remained largely theoretical and graduates struggled to gain employment as they were deemed too inexperienced in practical work.[117] Fitzgerald, having failed to convince the powers that prevailed in the college to support an adequate teaching laboratory, pondered, "When will poor TCD get credit for wanting to do more, very much more than its very limited and precarious income permits?"[118]

In sum, the Catholic hierarchy was erecting barriers to the new science in the classroom, which they perceived as a threat to Catholic education from scientific naturalists. Senior officials on the Board of National Education were unsympathetic to changes recommended by Fitzgerald and Trinity officials lacked the will and money to exact educational changes. The antitechnological feeling at third level, which so frustrated Fitzgerald in his quest to propel Dublin onto the world scientific stage, was percolating down to primary school education, and reluctance to implement changes seemed rife throughout the entire system. Dublin's connection with London was Fitzgerald's only lifeline for a long-term vision for science. Without it, he believed, the scientific potential of new generations of Irish would remain unrealized. Fitzgerald held such strong beliefs in the vital cultural and intellectual value of science that he lambasted proponents of classical education who excluded experimental science from education and left the population lacking in skills. As he put it, "The niggardly recognition of science by the public is a disgrace to the enlightenment of the nineteenth century . . . the public now are but the children of those who murdered Socrates, tolerated the persecution of Galileo, and deserted Columbus."[119] His chagrin extended also to a scientifically apathetic political system, which showed no signs of harnessing the economic potential of science, as he lamented, "Another matter that I cannot endorse is leaving out of the whole subject of political economy [in schools]. It is most important that those who have to govern the country in the future should have some dim ideas of what the questions they deal with are like, and by giving them a few broad principles should be saved from the more obvious fallacies which are the stock in trade of so many political charlatans."[120] These continuous broadsides at an Irish political and educational system, governed by those with "monastic book-wormy habits of thought,"[121] signaled a more drastic intention as he confided in one of his many letters to his colleague Oliver Lodge, "With this Home Rule looming in the near future, I cannot afford

FIGURE 4. The Applied Mechanics Laboratory at the Royal College of Science, Dublin ca. 1920. Such early twentieth-century classes in practical science at the RCSI were the legacy of late Victorian educational reforms campaigned for by George F. Fitzgerald and William F. Barrett. Reproduced by kind permission of UCD Archives UCDA RCSI/248.

to waste more money than I can help, as I shall almost certainly have to leave Ireland if it comes on."[122]

Fitzgerald's arguments for Home Rule drew on Spencerian notions of progressive evolution, when he forewarned that populations lacking in adequate scientific education and without the reasoning skills engendered by experimental science were unlikely to survive, let alone prosper. Home Rule, he implied, would be tantamount to the extinction of the "Irish race." Sounding these notes of caution to an Irish Industrial League meeting in May 1896, he stated, "The way that science bears on industry is that, for efficient work, and especially for improvement, for keeping up with the times, for withstanding the competition of the world, for raising themselves above the position of hewers of wood and drawers of water, for preventing extermination . . . a people must be provided with accurate information and with habits of accurate work, that is with scientific information and scientific methods. I am afraid the people of Ireland have neither the information nor the habits of science." But, of even graver concern to Fitzgerald than the prospects for

Irish industry, was the future of Ireland itself. "Not only does the survival of industry depend on such habits," he warned, "but the very survival of the Irish people, for preventing extermination like that of the Maori and the Red Indian, a people must be provided with accurate information and scientific methods."[123] As David Attis underlines, it was Fitzgerald's contention that the evolution of industry and civilization threatened extinction for those who failed to adapt.[124] Fitzgerald's Dublin cityscape in the 1890s, then, was interwoven with pressing scientific and societal concerns. On the one hand he was attempting to salvage his vortex sponge theory to secure the idea of a continuous universal ether, and on the other he was resisting the dissolution of local political space.

In Fitzgerald's view, the progress and prosperity of Dublin and the survival of its people was dependent on adaptation to the new science, and his solution to problems of politics and science was the same: the connecting links must be attended to and strengthened.

This chapter has demonstrated some of the ways in which the *lived* experiences of William Fletcher Barrett and George Francis Fitzgerald, two physicists working in late Victorian Dublin, helped to shape the spaces of science around them. It has highlighted the role of Dublin cityscapes in the development of their ethereal preoccupation in the late nineteenth century, and the ways their location in regard to this research, whether inside or outside Dublin's established Protestant parameters, influenced the debate on the constitution of the ether, and consequently on the origin of matter. Both practitioners viewed the properties of ether from different standpoints, uncovered its potential in different ways, and were firmly rooted in their ethereal convictions, but were united in mobilizing the *extraordinary complexity* of the ether to underpin their respective doctrines. But, in both cases, whether the ethereal priorities or preoccupations were with the spiritual or the mechanical, the race for definitive accounts or explanatory frameworks, as we have seen, revolved around local considerations.

The appearance of an article in the *Nonconformist* in 1875, by a scientist based at the Royal College of Science in Dublin, espousing the Christian potential of ether can be seen as the beginning of an attempt to shore up public morality against the encroaching tide of unbelief, while another scientist, a short walk down Dawson Street to Trinity College, was mobilizing the same illusive substance to shore up Anglican identity against the rising tide of Home Rule agitation. One was appealing explicitly to the dangers of "materialism," the other found "materialism" idealistically construed, an ally in a battle for unity and political cohesion.

Barrett was driven to protect society from Tyndall's "materialism" and the excesses of commercial life that he saw as providing a united front against the fundamental Christian values of brotherhood and selflessness. The poverty and disharmony he encountered while working in Dublin provided him with the space to promulgate his spiritualistic theories of the ether and at the same time attend to the physical and moral education of the underprivileged. Barrett's "life in science" serves to demonstrate how the modus operandi of this particular habitus helped to shape the institutional and pedagogical spaces around it and to challenge the prevailing climate of science.

Elsewhere in the city, the search for a canonical explanation of the ether for Fitzgerald was an attempt to underpin Protestant spaces in a time of precarious political geography—the very fabric of his life in Dublin was at stake and his dream of advancing the profile of Irish science and technology was threatened by a Nationalist post–Home Rule society. His location and *lived* experiences served to elucidate Edward Soja's conception of "the spatiality of human life" and demonstrate how this "new man of science" was a distinctly spatial entity in a complex relationship with his Dublin cityscape.

I end with a mention of Steven Connor's recent observation that nineteenth-century writings about the ether depended on a kind of dynamic imagination "focussed not so much on how things appear as forms, as on how they worked and felt, as actions and stresses."[125] This resounds well with J. H. Poynting's declaration nearly one hundred years ago that "physicists looked to mechanical models to explain the universe because of the nature of minds, rather than the nature of the universe. . . . [We are] able to think of ourselves as part of the connecting machinery, feeling the stresses and helping to make the strains."[126] These comments, nearly a century apart serve to underscore the contention of this chapter; that "the all-pervading ether" in late Victorian Dublin, was more than a disembodied scientific conundrum, it was a flexible resource being continually molded and reshaped by the contours of scientific lives in the city. The ether forged an important nineteenth-century space for science in which, as Connor configures it, a discourse on the "mentality of matter" and the "materiality of mind" could be played out.