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**Telescopes in the Drawing-Room: Geometry and Astronomy in  
George Eliot's *The Mill on the Floss***

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**An Astronomer Hating Women in General**

George Eliot's *The Mill on the Floss* (1860) has traditionally been considered by critics as a biographic working-through of Eliot's life, and is very rarely studied as a novel with a scientific dimension. This critical treatment contrasts with the many studies that situate *Middlemarch* (1872) and *Daniel Deronda* (1876) as novels informed by Victorian science. This article, however, proposes that Eliot engages both thematically and structurally with the science of astronomy in *The Mill on the Floss*. Eliot's novel confronts the notion that women should be excluded from the science of astronomy: an ideology transmitted in *The Mill on the Floss* through masculine modes of pedagogy. The telescope is central to how the novel considers astronomy: perspective in the text develops in relation to the observational capabilities of the telescope, how it transformed proximity and enabled distant objects to be viewed closely. In his "Studies in Animal Life," George Henry Lewes advocated for the study of minute things – frogs, parasites, insects and aquatic microorganisms – by stating that "they have a less imposing appearance than planets and asteroids, I admit, but they are nearer to us, and admit of being more intimately known" (61). In contrast to this sentiment, this article shows that Eliot applies astronomical modes of observation to the intimacy of the domestic sphere, where bodies stand in for celestial objects, and observation is assisted by telescopic apparatuses. By reading Eliot's novel alongside nineteenth-century astronomical documents, I show that an affinity is created between the astronomical and the domestic in *The Mill on the Floss*, a manoeuvre that allots complex human relationships in the form of the novel a legitimacy that merits scientific modes of observation.

*The Mill on the Floss* was published in 1860, but the action of the text takes place between the late 1820s and the mid-1840s. As is well known, the novel details the lives of Tom and Maggie Tulliver, siblings who grow up at Dorlcote Mill on the

River Floss. The astronomical dimension of Eliot's novel is considered, quite explicitly, within the broader paradigm of Victorian pedagogy, which is a central theme of the narrative. Early in the novel, Maggie visits her brother Tom at King's Lorton, where he has been sent to receive his education from the Reverend Walter Stelling. In the classroom, Maggie encounters *The Eton Latin Grammar*, which, like most pedagogical tools in language acquisition, comprises explanations of grammatical concepts along with tables of the different parts of speech. The short example sentences in the *Latin Grammar*, used to illustrate case, grammar, and mood or inflection, take Maggie's interest more than the linguistic rubrics; "she presently made up her mind to skip the rules in the Syntax – the examples became so absorbing" (147). For Maggie, these short sentences are transportive; little snippets of narrative that remove her from the schoolroom, and act as puzzles in their own right.

In her study of the *Latin Grammar*, Maggie becomes absorbed by one example in particular:

The astronomer who hated women generally, caused her so much puzzling speculation that she one day asked Mr Stelling if all astronomers hated women, or whether it was only this particular astronomer. But, forestalling his answer, she said,

‘I suppose it's all astronomers: because, you know, they live up in high towers, and if the women came there, they might talk and hinder them from looking at the stars’ (150).

While this is not the novel's only allusion to the science of astronomy, it is the point at which the gendered nature of Victorian astronomical practice is unambiguously addressed. The allusion is included at this point in the text to provoke: it argues for women's supposed incapacity to learn and create knowledge in a pedagogical space where Maggie far exceeds her brother in ability. *The Mill on the Floss* responds to the provocation by challenging the idea that women should be separate from the realm of astronomy. The misogyny encoded in the book of Latin grammar reveals an exclusionist outlook about women's place in scientific investigation and in the classroom. What I call the Astronomer's Provocation (the example comes from the actual *Latin Grammar*)<sup>1</sup> signposts several problems that the novel addresses: the exclusion of women from learned spaces, the power of female speech to disrupt modes of knowledge production, and the distancing of astronomy to high towers (that is, places that are neither familiar nor feminine).

If the high tower is typically associated with the trapped and helpless female subject, Maggie characterises the astronomer's tower as a space from which women are excluded. This representation effects a transformation of the fetishized trope of the imprisoned female, apparent for example in Alfred Lord Tennyson's "The Lady of Shalott" (1832). The Lady of Shalott survives in an isolated tower on a river that flows to Camelot:

Four gray walls, and four gray towers  
Overlook a space of flowers,  
And the silent isle imbowers  
The Lady of Shalott (355).

Trapped in the turret, she is cursed and forbidden from looking onto the outside world directly: her gaze is mediated by a mirror through which she can observe her surroundings. Escaping the tower, she floats in a boat to her death. If such spatial entrapment represents Victorian domestic values, "like the Victorian ideal of the domestic angel" who "remains pure only so long as she remains oblivious to any urge to join in the doings of the world outside her own feminine sphere" (Bowles 120), then Maggie's representation of the astronomer's tower as an appealing location subverts the characterisation of the high tower as a feminine and repressive space. It transforms, in other words, the site from a women's prison into a desirable location. Maggie's idea of the astronomer's tower is instead aligned with the representation of the tower in Constance Naden's poem "The Astronomer" (1894), which presents the observatory as a privileged site:

White, cold, and sacred is my chosen home,  
A seat for gods, a mount divine;  
And from the height of this eternal dome,  
Sky, sea, and earth are mine (3).

The distinction between the tower as feminine or masculine is contingent on optical purview (and, of course, the ability to move freely between tower and world). If the damsel so often looks out of a window to the prohibited world below (in Tennyson's poem this view is twice removed), the astronomer gazes upwards and outwards, with the aid of the telescope. For the astronomer, the tower (observatory) is not a place of seclusion, but a deliberately chosen vantage point. As such, Maggie's representation of the high tower in *The Mill and the Floss* is a strategic attempt to reconfigure this space from a site for women's imprisonment to a desirable space from which women are wrongfully excluded.

Maggie resists a similar exclusion over the course of her stay at King's Lorton, where she is positioned as a spectator to Tom's education, desperately attempting to break into the transmission of knowledge from male teacher to male student. Maggie expands the example from the *Latin Grammar* to create a narrative where women's discourse is understood as an active impediment to knowledge. The high tower is represented as the locus of knowledge creation, and as a place that should be out of reach from the chatter of women. During Maggie's visit, her speech is likewise marked for its propensity to interrupt, even though (at this point in the novel) her talk is perceived as non-threatening. Mr Stelling, who "liked her prattle immensely" (150), diminishes Maggie's serious academic inquiry to seemingly inconsequential talk aligned with gossip – "prattle" is a term almost akin to nonsense. Tom likewise comments on Maggie's propensity to talk: "my sister Maggie is always wanting to tell me stories – but they're stupid things. Girls stories always are" (165).

Tom articulates a general attitude of the mid-Victorian period towards women's involvement in what were then considered the serious and legitimate fields of knowledge production. Similarities exist between Eliot's biography and the representation of Maggie in *The Mill on the Floss*, and while it is problematic to unequivocally conflate Eliot and Maggie, it would be negligent to overlook the glaring parallels. Eliot's own frustrations as a young woman seeking, and with an aptitude for, education, manifest in the narration of Maggie's time in the classroom. While Eliot was a gifted student, she was highly critical of the schooling system in which "the course of studies for young women was unintellectual, for demanding

subjects were seen to be incompatible with female frailty" (Dodd 70). Mr Stelling certainly upholds this viewpoint, speaking of Maggie, he asserts: "They [girls] can pick up a little of everything, I daresay . . . they've a great deal of superficial cleverness; but they couldn't go far into anything. They're quick and shallow" (150).

In his two sociological studies, Herbert Spencer (1820-1902) argued that "women had been arrested intellectually in order to conserve their limited supply of energy for procreation" (Gates 14). Victorian medical theories that considered the female brain and reproductive organs to be inextricably linked led medical professionals to conclude that "women should simply not be faced with the rigours of an education paralleling men's" (Gates 15). While there were several Victorian women known as scientists or science writers, such as Agnes Mary Clerke and Mary Somerville, the common understanding was that education and scientific study, especially in the physical sciences like astronomy, was a masculine pursuit. Consider John Ruskin's essay *Sesame and Lilies* (1865), which was published five years after *The Mill on the Floss*. In relation to science, Ruskin advocated for supporting the sciences financially, arguing that Britain's finest scientific discoveries were "all done in spite of the nation: by private people's zeal and money" (50). Ruskin's encouragement stops short, however, of being applied to women, who should take a merely subsidiary interest in science: "a man ought to know any language or science he learns, thoroughly – while a woman ought to know the same language, or science, only so far as may enable her to sympathise in her husband's pleasures, and in those of his best friends" (82). The echoes of Mr Stelling (and the example of the misogynist astronomer in the *Latin Grammar*) are overt. Yet while Maggie may be subject to such repressive ideologies, women, including Eliot herself, still managed to find ways to work against the institutional barriers that sought to limit their scientific participation.

Contemporary critics consider Eliot to be scientifically engaged and conversant with theories in virtually all fields of Victorian science.<sup>2</sup> Eliot's *Diary 1854-1861* (the period during which she researched and wrote *The Mill on the Floss*) is replete with references to her scientific investigation, both scholarly and physical. She constantly documents instances of her scientific reading (56, 67) and botanical investigations (61). Of the 2405 items that comprise what still exists of the Eliot-Lewes collection, 965 of these are concerned with various scientific disciplines (Baker xx). In relation to astronomy, the collection includes Sir George Biddell Airy's *Gravitation and Six Lectures on Astronomy*, Dominique Francois Jean Arago's *Popular Astronomy*, Edmund Beckett Denison's *Astronomy Without Mathematics*, Sir John Herschel's *A Treatise on Astronomy and Familiar Lectures on Scientific Subjects*, Dionysius Lardner's *Handbook of Natural Philosophy and Astronomy*, and Sir Joseph Lockyer's *Astronomy*. This catalogue, and Eliot's diary, clearly show Eliot as being interested in, and well-informed of, contemporary scientific discoveries in the field of astronomy.

Eliot's engagement with astronomy has been, while certainly understudied, critically discussed. Two examples are Anna Henchman's work on *Daniel Deronda* (*The Starry Sky Within* 158-95), and Sally Shuttleworth's brief but illuminating account of astronomy in *Daniel Deronda* in *George Eliot and Nineteenth-Century Science* (176-80). The critical focus on *Daniel Deronda* is unsurprising, as the novel contains Eliot's most-quoted references to astronomy, including:

Solitude in any wide scene impressed her [Gwendolen] with an undefined feeling of immeasurable existence aloof from her, in the midst of which she was helplessly incapable of asserting herself. The little astronomy taught her at school used sometimes to set her imagination at work in a way that made her tremble: but always when someone joined her she recovered her indifference to the vastness in which she seemed an exile (52).

The immense expanse of space provides a metaphor for Gwendolen's feelings of solitude; and the disconnect between Gwendolen's world (her social sphere), and whatever it is that exists out there (which Gwendolen can only conceptualise as "the vastness") is made apparent.

When Gwendolen meets her future husband, Mallinger Grandcourt, she is disappointed that he does not dance with her as has been predicted by her social circle; she laments: "it was ridiculous of elders to entertain notions of what a man would do, without having seen him even through a telescope" (96). Yet Gwendolen notes that "he did sometimes quietly change his position according to hers, so that he could see her whenever she was dancing, and if he did not admire her – so much the worse for him" (97). Telescopic modes of observation become transposed onto the ballroom. Grandcourt is unknowable without an apparatus of focused magnification, and the telescope metaphor protracts as Grandcourt is imagined to mimic an astronomer adjusting his telescope to follow a moving celestial object (Gwendolen). Astronomical modes of observation in the domestic sphere, fleshed out in this example from *Daniel Deronda*, are structurally modelled in Eliot's earlier novel, *The Mill on the Floss*. Geometry and empiricism are debated in the King's Lorton classroom and these scientific and mathematic paradigms become reified in the novel by the movement and placement of corporeal bodies: astronomical observation is augmented in the narrative as a structuring apparatus that directs forces of romantic desire.

*The Mill on the Floss* is situated in an era of great astronomical advancement, particularly with respect to telescopes. The telescope, theoretically, allowed scientists to see very large and very distant objects with more clarity than human eyes. The reality, however, was far from certain: faults with the tools, technologies, and methods of astronomical observation were necessarily entangled with the production of astronomical knowledge, and were of equal interest to the Victorian public. Telescopic observation was characterised by focus and magnification of objects, the collection and reflection/refraction of light, and spatial positioning. These issues directly correlate to how relationships between people are codified in Eliot's novel. Telescopes not only structure the romantic interactions plotted between characters, but this metaphor of telescopic perspective is also used to interrogate the limitations of scientific observation, and thus question how a novel makes human observation possible. Such a focus identifies the fact that scientific modes of observation collapse when human subjects, not inanimate objects, are examined.

Geometry plays a central role in the science of astronomy and in Eliot's novel. Most Victorian pupils came in contact with geometry through Euclid's *Elements of Geometry*. Alice Jenkins explains that "for most of the Victorian period, mathematics and classics were the staple disciplines of English education for boys and men of the well-to-do classes . . . such students were taught Euclid's *Elements* in the same way as they were taught Latin: as the essential training of a gentleman" (74). Geometry



taught students "to reason in an abstract realm removed from sensory perception" (Jenkins 74).

Geometry escapes Tom's grasp in the classroom, "he was in a state bordering on idiocy with regard to the demonstration that two given triangles must be equal – though he could discern with great promptitude and certainty the fact that they were equal" (139). Theoretical or non-empirical knowledge needs to be proven, or "demonstrated," but perceptually it is just known, the triangles simply "were equal." Maggie's experience with Euclid's geometry is equally unsettling: "she began to read with full confidence in her own powers, but presently, becoming quite bewildered, her face flushed with irritation. It was unavoidable – she must confess her incompetency, and she was not fond of humiliation" (147). Educational institutions and resources were particularly hostile to women who wanted to study geometry. Jenkins explains that "efforts to make geometry accessible to middle- and lower-class male learners were not quite mirrored in girls' and women's education. Virtually no geometry textbooks were published in Britain aimed specifically at female learners" (75-6).

Maggie responds to Euclid with embarrassment, yet the flushed face and panicked puzzlement border on the erotic, and this will not be the only time mathematics and mortification are fused in the novel. Geometry in the schoolroom, as Tom comes to find, seems removed from the material world. Yet geometry by its very definition is concerned with the properties of space and the relative position of figures, and was essential to the study of astronomy and the construction of telescopes. Geometry is used to measure the distance between two discrete points, and the concepts of astronomical and spatial distance inform how both physical and mental distance between people is conceptualised in *The Mill on the Floss*. Euclid may be grossly inaccessible to both male and female pupils, yet Eliot's novel proves how essential spatial relations are in a human context, and renders abstract geometry into something tangible.

### **Eliot and Victorian Telescopy**

Eliot takes the geometric models and the astronomer looking through his telescope from the schoolroom and transplants these into the domestic space of the provincial town of St Ogg's. Book 6 of *The Mill on the Floss* details the complex courtship plot between Maggie, Philip Wakem, and Stephen Guest. Stephen and Lucy Deane, Maggie's cousin, are in the early stages of courtship before Maggie comes to visit St Ogg's after her father's death. Stephen, Lucy, and Philip are a small social unit. Maggie enters this domestic scene and usurps Lucy's role as love interest to Stephen. Meanwhile, Lucy (and Philip) believe Maggie and Philip to be in love, and that the only obstacle preventing their union is the long-standing family feud between the Tullivers and the Wakems. Tom and Philip were schoolfellows before Maggie and Philip developed a closer friendship. Philip has previously confessed his love for Maggie, calling her "the day-star of his life," but she sought to keep the relationship platonic, and is eventually forbidden to see him by Tom (333). Lucy is unaware that a complex love triangle has formed between Maggie, Stephen, and Philip. This courtship configuration is complex and intricate: there are several narratives and counter-narratives working simultaneously, and information is revealed and discovered slowly and selectively by and to each character. Visual observation, looks and glances (often given substance as beams of light), and the deliberate angling of bodies, underpin and organise several scenes of encounter between the characters.

When Maggie makes a second visit to Mr Stelling's schoolroom later in the novel, she finds that Tom now has a classmate, Philip. As Maggie sits in the study watching Philip and Tom work, their bodies create a triangular spatial formation. This is the first instance such a composition is explicitly spelled out:

She sat on a low stool at nearly a right angle with the two boys, watching first one and then the other; and Philip, looking off his book once towards the fireplace, caught the pair of questioning dark eyes fixed upon him . . . her eyes were full of unsatisfied intelligence, and unsatisfied, beseeching affection (177-8).

In a geometric sense, Maggie sits at the vertex of this configuration (the point where two line segments meet). The arms of the triangle are drawn by her line of sight as she looks from one boy to the other. The triangle here is comprised of Maggie, Tom, and Philip, but later Tom will be replaced by Stephen. Before this occurs, and before Maggie visits St Ogg's, Philip discusses narrative archetypes and foretells the usurping of the "blond-haired young lady" (Lucy) by the "dark woman" (Maggie): "well, perhaps you will avenge the dark woman in your own person, and carry away all the love from your cousin Lucy. She is sure to have some handsome young man of St Ogg's at her feet now: and you have only to shine upon him – your fair little cousin will be quite quenched in your beams" (332). The light imagery is significant; the telescope only works by collecting enough light, and angling mirrors and/or lenses in the right way, to produce a clear image. In Philip's foretelling, narrative and astronomy intertwine: Maggie is a brighter celestial object than her cousin, who will become perceptually extinguished by her presence.

Phyllis Susan Dee reads the several complex love triangles in *The Mill on the Floss* through René Girard's paradigm of triangular desire (391). Dee argues that the juvenile relationship between Maggie and Phillip cannot mature because Maggie lacks sexual desire for Phillip: "the child Maggie returned Phillip's love eagerly, but sexual desire has complicated the triangular relation. Once Maggie experiences the erotic fascination of Stephen, she can only envision a marriage to Phillip as sexual sacrifice" (404). Dee's analysis is astute and complex, yet these triangulations are not merely psychological configurations: they are spatially plotted (in both senses of the word) and reflect the mathematical and observational paradigms of Victorian astronomical inquiry.

To show the complexity of Eliot's astronomical formal structures, it is important first to outline the developments to telescopic technologies in the Victorian period that informed Eliot's writing. Three large-scale telescopes in particular attracted considerable interest as hubs of important astronomical work. Sir William Herschel's 40-foot reflecting telescope was built in the late seventeenth century by Herschel and his sister Caroline, and was in operation until 1840. Lord Rosse's telescope, the Leviathan of Parsonstown, built between 1842 and 1845, improved on Herschel's by fourteen feet and "was the first to rival Herschel's telescopes in light-gathering power" (Henchman, "Telescope as Prosthesis" 29). In 1847, The Great Refractor telescope was also installed at a new Observatory in Cambridge, Massachusetts. An equatorial telescope, it was constructed with the mobility to follow one object across the sky over the course of a day, rather than remain stable. While these big objects held in distant institutions and remote locales seem to perpetuate a disconnect between public and professional scientific practice, the periodical press

also reveals that an interested public contributed to and participated in the science of astronomy, and were reading about astronomical discoveries and debates on a regular basis.

An article in *Reynold's Miscellany* by Charles Sturgeon, a barrister-at-law, registers an active public interest in the practice of astronomy, and also the (financial/institutional) barriers thwarting amateur observation. In "Telescopes for the Million," he instructs the reader how to make "an effective Telescope, to view the Heavens, for the small outlay of *three shillings*" (110; emphasis original). While the article is largely a practical account of how the layman can construct a telescope, it also taps into the ideology surrounding institutionalisation:

My aim is that the labouring classes of my fellow-countrymen may obtain at a trifling cost, an opportunity of studying the sublime features of the starry night, without being deterred as too many are by the formidable expense supposed necessary for attaining a knowledge of a few of the shining worlds around us (110).

Sturgeon's article displaces the practice of astronomy, bringing it from the academy to the public sphere, and even further down to the domestic sphere, as the telescope makes use of common household trinkets: a pill-box for the eye-piece of the telescope, and sealing-wax to hold the objective lens in place. In an analogous way, Eliot brings modes of telescopic observation into the home.

The function of the telescope is relatively simple: it "collects light from faint and distant objects" and then "magnifies their images" (Ridpath 494). Telescopes use either an objective lens or a mirror to gather and focus light, using either refraction or reflection. Reflecting telescopes, like Herschel's and Rosse's, use concave mirrors to focus light. Herschel's 40-foot telescope was a reflecting telescope that used one large mirror; that is, incoming light enters the aperture and bounces off the mirror at a precise angle to the eyepiece. Rosse's *Leviathan* was a Newtonian telescope, which is a type of reflecting telescope that uses two mirrors. Incoming light bounces from one large mirror to a smaller, angled mirror, and is then directed to the eyepiece. A refracting telescope (like *The Great Refractor*), conversely, focuses light from a lens to an eyepiece. The telescope is a tool that relies on mathematic and geometric precision in its construction, especially in terms of the curvature and placement of mirrors within the optical tube. Apart from the precise construction of the instrument, observation is also contingent on environmental factors, such as cloud cover or an individual's eyesight. Precision in construction is paramount, and environmental variables need to be favourable to enable proper vision. As Martin Willis explains, "telescopic vision . . . engaged the observer in a strobic contest to collect data in the brief moments when both the telescope's apertures and the atmosphere through which it had to penetrate allowed optical clarity" (61).

While telescopes had to contend with environmental factors, they were more often praised in the era for extending human capabilities. Large telescopes became objects of public interest, as is evident in the spectacle surrounding Herschel's telescope. An 1840 article in *The Mirror* "Consignment of Sir John Herschel's Telescope to its Last Rest" narrates the "funeral" of Herschel's 40-foot telescope, by his son Sir John Herschel. The telescope had to be dismantled for the large wooden structure had started to rot. In this article, the telescope exceeds its designation as a tool of observation and is heavily (and humorously) personified. "The reverend old



telescope, [whose] 'broad bright eye' that once mightily scanned the heavens" is laid to rest (281). The telescope is effectively "dressed" for the ceremony when "the reflector of the telescope was brightly polished for the occasion," and a song was written by John Herschel and performed by the congregation (reprinted in full in the journal), "all the party joining in the chorus; after which they again marched round the telescope" (281). The song, while amusing, emphasises the superior instrumentality of the telescope over the human eye:

There are wonders no living wight hath seen,  
Which within this hollow have pictured been,  
Which mortal record can ne'er recall,  
And are known to Him only who made them all (281).

Henchman discusses the idea of the telescope as prosthesis, "by adding to what the human body can do, telescopes hold strong structural similarities to such prosthetic devices as artificial hands, legs, or teeth: they extend human vision into distant regions of space, supplementing the capacities of a healthy eye and enabling a vastly intensified level of perception" ("Telescope as Prosthesis" 27). Herschel's poem certainly asserts the instrument's superiority of vision, giving the telescope itself a privileged position for seeing things that even the astronomer could not yet discern. However, *The Mirror's* account distorts the telescope from a simple prosthetic device into something more elevated: a funeral for an inanimate object gives that object an agency that is effectively human. Examples like this question the status of the telescope as a mere tool, and play into what Henchman frames as "debates about whether new human knowledge is best understood to derive from the abilities of the human mind or the power of the technological instrument" ("Telescope as Prosthesis" 32).

The telescope extended human capabilities, yet technological advancements led to continuous processes of improvement, and thus the status of the telescope was recurrently debated. Michael McKeon argues that in the seventeenth century the telescope raised questions as to the limits of scientific and sensory observation. He quotes Henry Stubbe (an English physician and scholar), who suggested "not only that telescopes are not 'as certain as our eyes' but also that even 'if they were as certain as our eyes ... yet the employing of that only sense would never assure us of what we see'" (71). In the seventeenth century eyewitnesses and human observation were preferred as distrust in scientific instruments prevailed (McKeon 72-3). This shifts in the nineteenth century, when the telescope is thought to see more than can be communicated to the human eye.

The telescope functioned in the nineteenth century in an intellectual climate fraught with uncertainty. The definition and substance of light, the meaning of an image, and what it meant to view something, were all in contention, and subject to disputation (Armstrong 272-316).<sup>3</sup> Microscope users questioned whether what they saw actually existed, for the magnified objects they were viewing were mostly invisible to the human eye, whereas telescope users could see celestial bodies, yet were concerned about the distorting impact of the immense distance between object and telescope (Willis 61). Astronomy as a discipline was especially concerned with the limits of empirical observation: "astronomy was always, to some extent, concerned with optical knowledge. . . . [A]stronomers vacillated between ontological and epistemological positions, sometimes readily accepting the evidence obtained

through the use of the telescope, and at others beset by optic nervousness" (Willis 59). These examples expose both the increasing efficacy of telescopes, and the fraught scientific climate in which these advanced instruments were operating.

Questions concerning the status of the telescope (mere tool to the astronomer, or anthropomorphised object) informed debates about the merits of empirical observation over theoretical astronomy, especially in relation to the eighteenth century's most prominent astronomer: William Herschel. Herschel refocused astronomical investigation to privilege "empirical observation through telescopes" rather than mathematical theory in the era (Henchman, "Telescope as Prosthesis" 29). Michael Crowe asks, "should Herschel be viewed primarily as an observational or as a theoretical astronomer?" and explains that Herschel did not use higher mathematics in much of his practice, unlike his contemporary Pierre-Simon Laplace, who "employed sophisticated mathematics" in his study (76).

### Telescopes in the Drawing-Room

The relationships between characters in *The Mill on the Floss* are, like the astronomical investigation of celestial objects, represented as moments of encounter necessitated by optics and observation. Maggie is repeatedly represented as an object of study, or a literal body that draws the eye. She attracts the notice of St Ogg's society because she "had the advantage of being quite unfamiliar to the majority of beholders" (399). She is a new object, and the people she encounters are framed as observers ("beholders"). Because Stephen and Maggie cannot outwardly explore their desire for one another (due to their previously established and publically known connections to Lucy and Philip respectively), emphasis is placed on a non-verbal mode of communication: looks and glances. Reflecting on an encounter with Stephen, Maggie becomes "conscious of having been looked at a great deal" (384), she also participates by "glancing" at Stephen (406). Stephen's desire to observe Maggie is a monomania: "he only wished he dared look at Maggie, and that she would look at him – let him have one long look into those deep strange eyes of hers, and then he would be satisfied and quite reasonable after that" (406).

While Maggie and Stephen observe each other, Philip observes them. In one particular instance, Stephen, Philip, and Lucy are at the piano and Maggie is seated doing needlework. She is aware that Stephen can see her for "it was his habit always to stand so that he could look at her" (416). Stephen, during a lapse in the singing, fetches Maggie a footstool; she thanks him with a look, and "nothing could prevent that mutual glance from being delicious to both" (419). Philip, from the vantage point of the piano, observes this:

This sudden eagerness in Stephen, and the change in Maggie's face, which was plainly *reflecting a beam from his*, seemed so strong a contrast with the previous overwrought signs of indifference, as to be charged with painful meaning. . . . he wanted to go home at once that he might *reflect* coolly on these false images, till he had convinced himself of their nullity. But then, again, he wanted to stay as long as Stephen stayed – always to be present when Stephen was with Maggie (419; emphasis mine).

The metaphoric light from Stephen's face reflects on to Maggie's face, which is in turn seen by Philip. Until these configurations are in place, Philip has had no way to discern the desire that exists between Stephen and Maggie. From this point, Philip

casts himself as an observer, "always to be present," watching (and "reflecting" on) the interactions between Stephen and Maggie, who are figured here as bodies and surfaces that both project and reflect light.

The St Ogg's bazaar is the setting for a spatial arrangement that will bring to Stephen's attention the fact that Philip and Maggie are (or were) romantically connected. The hall where the bazaar is set up is meticulously described, with particular attention given to the light, which "shed down from a height on the many-coloured show below" (430). When Stephen tries, indiscreetly, to talk to Maggie, she is aware that Philip is watching from an elevated angle (Philip is sitting upstairs, which offers "a commodious point of view" of the scene below [430]). Stephen asks:

'Are you angry with me? What have I done? *Do* look at me.'

'Pray, go away,' said Maggie, looking at him helplessly, her eyes glancing immediately from him to the opposite corner of the orchestra, which was half hidden by the folds of the old faded green curtain. . . . Stephen turned away at once, and, following her upward glance, he saw Philip Waken seated in the half-hidden corner, so that he could command little more than that angle of the hall in which Maggie sat (433; emphasis original).

By situating himself between the curtains at an elevated angle of the hall, Philip focuses his attention on the direct angle Maggie occupies; the chink in the green curtain operates as a telescopic eye-piece, where the field of vision is narrowed down and external light is blocked out. Resembling celestial objects, Maggie and the townspeople are non-static, so Philip trains his telescopic gaze on Maggie.

Fixing one's gaze on a moving object for an extended period of time was a central concern not only to jealous suitors such as Philip but also to nineteenth-century astronomy more generally. To overcome the challenge of observing an object in continual motion, Philip must use the materials at hand (the curtain, his position of observation, and light) to create the conditions for looking at his object of study, much in the way nineteenth-century astronomers had to develop the tracking capabilities of their telescopes. See for instance the description of this technical innovation in an 1847 article in the *Literary Gazette*:

To counteract the apparent diurnal motion of the celestial objects, which is continually throwing them out of the field of ordinary telescopes, (a great annoyance, especially when high powers are employed,) a clock-work is attached to the equatorial axis. . . . The effect of this arrangement is to keep the object for several hours constantly in the centre of the field of view (Mitchell 641).

Like the clock-work mechanism, Philip's gaze is fixed exclusively on Maggie (whom he has previously called his "day-star"). Stephen, hitherto oblivious to Philip's observation, has a moment of realisation about the relationship between Maggie and Philip after he discerns this configuration.

Observation and distance are intertwined in relation to Maggie, Stephen, and Philip. Maggie grapples with upholding social mores, while also attempting to balance her desire for Stephen with her inward feeling that what she is doing is harmful to those she cares about. As Tom remonstrates: "at one time you take

pleasure in a sort of perverse self-denial, and at another you have not resolution to resist a thing that you know to be wrong" (393). The conflicting modes of denial and indulgence that Maggie wrestles with confuse those around her, especially her two suitors. In this sense, the proximity problem of astronomical observation becomes inverted: the characters are often contained in small domestic spaces, where they exist in close proximity and have moments of contiguity, yet human consciousness is what is distant and inaccessible. Philip, agitated after his observations at the bazaar, questions whether he has a claim to Maggie's unwilling interiority: "and had he any right to ask her for a revelation of feeling which she had evidently intended to withhold from him?" (462). Because Stephen and Philip are perplexed by inconsistencies and distance, they turn to careful observation.

These examples replicate a telescopic apparatus: moments of revelation always require light to expose something, as the telescope did. This light is either physical (the sunlight in the St Ogg's hall), or emotive, such as the "beam" that passes from Stephen to Maggie. If "the new instruments of nineteenth-century science were often seen to embody the qualities of the ideal human subject" (Tresch 269), in my reading, the distinction between scientific instrument and human subject collapses: the human *becomes* the instrument. The telescopic poetics that occur in the final third of the novel culminate in the moment when Maggie withdraws from Stephen's plan to elope. Lucy contrives a boat trip for Maggie and Philip, offering them an opportunity to be alone together. Philip, sick with the realisation that Maggie has feelings for Stephen, opts out, which allows Stephen to take his place. The mood that characterises their flight is one of fluid, hypnotic motion; Stephen rows "half automatically," they exist in an "enchanted haze," and Maggie is liable to "fits of absence" and "thoughtlessness" (464-6). A symbiosis exists between the mental abstractedness and the hypnotic, repetitive act of rowing. The trance-like state gains momentum through a suspension of rational thinking and speech, the locus of attention is on the present tense.

The idea of being lost in abstraction mimics accounts of astronomical observation, where astronomers would vacillate between serious inquiry, and wonder at what they were seeing. Francis Baily, in an 1858 edition of *The Leisure Hour*, wrote of his observations of an annular eclipse:

I was in expectation of meeting with something extraordinary . . . so fascinating and attractive, that the mind was for the moment distracted, and lost in the contemplation of the scene, so as to be unable to attend to every minute occurrence. . . . I was so riveted to the scene, that I could not take my eye away from the telescope to note down anything during the progress of this phenomenon (158).

Baily's distraction mimics the intoxication Stephen and Maggie feel in each other's presence: Maggie "was absorbed in the direct, immediate experience, without any energy left for taking account of it and reasoning about it" (403). Similarly, Stephen "was determined not to think – not to admit any more distinct remembrance than was urged upon him by the perpetual presence of Maggie. He was looking at her, and she was on his arm" (408). Like Baily's account, the tense shifts from reflections occurring in Stephen's consciousness to the action of the present moment. What becomes apparent is the inability to focus when in the presence of the phenomenon (or the object of desire).

The telescopic schema reaches its climax at this moment in the text. Stephen is described as "looking into her deep, deep eyes – far-off and mysterious as the starlit blackness, and yet very near, and timidly loving" (463). The contradictions are of proximity and affect: Maggie's eyes are characterised as being both distant *and* near, cryptic *yet* tender. The comparison to the cosmos, the "starlit blackness," is apt, for Stephen metaphorically telescopes in and out of Maggie's eyes, where the eyes are spherical orbs that are simultaneously close and distant. The conceptualisation of the human eye as an infinite galaxy, in a body that is physically near yet mentally remote, reflects the mid-Victorian fascination with instruments of magnification. Darwin, in 1868, wrote of the microscope that "Each living creature must be looked at as a microcosm – a little universe, formed of a host of self-propagating organisms, inconceivably minute and as numerous as the stars in heaven" (404). Maggie, who believed herself to be excluded from the astronomer's high tower, quite explicitly *becomes* celestial in this moment; she is interpreted as though she too were an astronomical object of study. The microscope magnified things that were close, that were familiar, but the telescope magnified celestial bodies that were very large and very distant: that distinction collapses in this passage as Maggie is at once close and distant. Distance problematized observation and perception, and the distance problematic was uniquely astronomical. As Willis argues, telescope users "knew that many of the objects they looked at were real" yet were "worried whether any elements of the spatial distance intervening between the object and the telescope had interfered with the accuracy of their seeing" (61). At this point in the novel, mental distance is just as perplexing and disconcerting as the immense distance of astral objects: other minds can never be completely, objectively accessed.

The immense and infinite galaxy is also disconcerting in this section of the novel. While Stephen, during their flight, is "hardly conscious that there were stars – living only in the near and distant future" (470), Maggie dreams about and wakes to celestial images:

She was in a boat on the wide water with Stephen, and in the gathering darkness something like a star appeared, that grew and grew till they saw it was the Virgin seated in St Ogg's boat, and it came nearer and nearer, till they saw the Virgin was Lucy and the boatman was Philip – no, not Philip, but her brother, who rowed past without looking at her . . . she seemed to awake, and find she was a child again in the parlour at evening twilight, and Tom was not really angry. From the soothed sense of that false waking she passed to the real waking – to the splash of water against the vessel, and the sound of a footstep on the deck, and the awful starlit sky (470).

In the dream, Lucy becomes a star and Maggie wakes to observe, unlike Stephen, the "awful" sky. If Stephen thinks only of the future, the stars, which are revealing light from some moment in the past, rouse Maggie from the present perpetual momentum of their elopement.

Eliot revises poetic cosmological conventions in *The Mill on the Floss*, and the prophetic dream signals the schism from old to new modes of astronomical understanding. Lucy is personified as a mythical star, and Stephen has previously evoked an older poetic tradition of staring into his lover's eyes, which are figured as celestial windows to the soul. However, in a novel that intersects with astronomical practices to explore desire and distance, Maggie's waking to the "awful starlit sky"



has a sobering impact. If nineteenth-century astronomy was revealing a universe in constant motion, the "awful starlit sky" reminds Maggie that, conversely, she has control over the momentum of her narrative trajectory (entrance into the marriage plot).

The full force of the word "awful" is evoked as the starlit sky denotes a galaxy that is in constant motion, at once terrifying and sublime. *The Mill on the Floss* creates an affinity between forces of desire and perpetual motion, for Maggie and Stephen's elopement is likewise figured as having unstoppable momentum as an almost unrelenting force. This is best symbolised by the river Floss as it carries Maggie and Stephen to Mudport. Even after Stephen lays down his oars, the "boat glided without his help," (464); Stephen latches onto this unprovoked movement to justify the inevitability of their elopement – as if it were sanctioned by a universal law. The "awful starlit sky" brings their accelerating movement to a standstill, as it prompts Maggie to attempt to halt the seeming unstoppable momentum of her own narrative fate.

Maggie's speech act after this dream finally halts the fluid reverie and elopement: "Maggie felt it was time to speak: it would only be unkind now to assent by silence. She spoke in the lowest tone, as he had done, but with distinct decision. 'We shall not be together – we shall have parted'" (473). Stephen has hitherto been unaware of Maggie's resolution not to elope, but the stream-of-consciousness narration spells this out before it is verbally stated by Maggie. In a cyclical movement, the instance at which Maggie's verbal assertion has power recalls Mr Stelling's classroom where the juvenile Maggie was chided for prattling. If observation brought Maggie and Stephen together, it is adamant speech that sunders them apart. The example of the astronomer hating women in general becomes actualised here: Maggie's eyes are described as star-filled galaxies. And Maggie's schoolgirl assertion was that astronomers hate women generally because they "might talk and hinder them from looking at the stars"; quite literally, Maggie's talk separates her from Stephen. Maggie's speech in the classroom was figured as profuse and prattling; it is here characterised as powerful and authoritative. The astral imagery that punctuates the near-elopement is the culmination of the two sections of the novel where astronomy is most prevalent: the schoolroom and the domestic sphere of St Ogg's. The schoolroom emphasised the gendered nature of scientific discourse and the exclusion of women from this intellectual space, and the courtship revolved around the limitations of even the most considered observation. Although Maggie's inner monologue is unobservable to Stephen, her spoken assertion that they must part is effective, it has power.

### **Geometric and Narrative Plotting**

Moments of revelation, when Philip or Stephen realise something about Maggie's feelings, are meticulously drafted by Eliot in the narrative, as if she has drawn a Euclidean diagram on the page, where line segments bisect at precise angles. For example, the line Philip constructs to ensure he constantly has Maggie in his field of vision could be labelled "PM," and the line where Stephen watches Maggie labelled "SM," and "SP" when Stephen notices Philip, so that points P, M and S are end points on line segments that continually shift and move. Without being overly simplistic (or drawing this analogy too far), if Maggie, Philip, and Stephen are all figured as discrete points on a spatial plane, it is not surprising, mathematically, that they do not unite (that is, enter romantic union or the marriage plot). Like parallel lines that never

meet, the novel plots these three characters as three separate points (M, P, and S), which can be close and can be distant, but which can never overlay. A cataclysmic event, the final flood that concludes the novel with the dual death of Maggie and Tom, is required to override the rules of mathematics: unlike Stephen and Maggie in their rowboat, Tom and Maggie *do* intersect, at the very last moment. Until this point, distance between characters is foregrounded both by telescopic mechanics and by the rules of geometry. Yet in their death embrace, Maggie and Tom are explicitly connected: "brother and sister had gone down in an embrace never to be parted" (521); an overt reversal of Maggie's imperative to Stephen: "We shall not be together – we shall have parted." (473).

The final sentence of the novel (relaying Maggie and Tom's tombstone inscription) reads: "in their death they were not divided" (522). A divided integer denotes a quantity that was once considered whole but is no longer; the diction of the last sentence is overtly mathematical. In a text that intersects geometry, astronomy, narrative, and human relationships, the image of two beings fused together, of two integers "not divided," lends irrefutable proof (in the mathematical sense) of the filial bond between Maggie and Tom. Lurking behind the scenes of the courtship plot is Maggie and Tom's strained relationship: Maggie refuses Philip on these grounds: "the tie to my brother is one of the strongest. I can do nothing willingly that will divide me always from him" (444). Of course, Maggie's refusal of Philip is partially due to her lack of desire for him. Nevertheless, she understands her relationship with her sibling as sacrosanct. Yet the fragility of this familial connection is made overt by its unlikelihood. It is both the most natural union (from birth) and the most unnatural; a reunion only made possible by the flood, a quasi-Biblical *deus ex machina*.

The telescopic and geometric relations between characters come into full effect at the novel's conclusion. In terms of narrative convention, Eliot eschews a traditional happy ending and avoids the marriage plot resolution. Eliot's ending was controversial at the time of publication and continues to be divisive. Nina Auerbach states that Maggie's "much criticized apotheosis and death in the final flood . . . raise more questions than they resolve" (164). June Szitotny argues for a biographic reading of the text, for she sees this as a way to understand Maggie's rejection of the marriage plot, and thus an answer to "one of the most vexing problems in George Eliot scholarship": why Maggie rejects romantic love (178). Likewise, an unsigned 1860 review of the novel asserts that, "the conclusion is essentially melodramatic," and although "admirable in parts, *The Mill on the Floss* is a failure on the whole" ("The Mill on the Floss" 198). It is my contention, however, that Eliot is running conceptual experiments with the marriage plot by following the rules of mathematics and astronomical investigation rather than the rules of narrative convention. Yet if *The Mill on the Floss* heavily intersects with astronomical and geometric praxes, the final flood (a plot device generated from the Romance tradition rather than realism) in all its improbability, gives novelistic convention precedence. It is unexpected, disappointing, and unlikely. In this sense, it demonstrates that a novel does not need to follow any specific formula *exactly* (unlike a theorem).

In *The Mill on the Floss*, Eliot brings astronomical modes of observation into the domestic sphere. The technology of the telescope is replicated spatially by the characters in the novel and, by representing observational astronomy in a domestic space, the novel asserts that human life and relationships are complex social relations that merit scientific, not merely psychological or affective, apparatuses of investigation. But Eliot not only replicates the mechanics, and the ideological

conundrums, of telescopes: she reclaims astronomical discourse by applying it to the novel. While scientific and literary discourses were closely entwined in the Victorian period, these two disciplines continued to transect as science became increasingly institutionalised and complex; the demands of new discoveries likewise created new and esoteric scientific dialects (Beer, *Open Fields* 174-80). In this context, Eliot's use of astronomical motifs in *The Mill on the Floss* is significant: it shows that these scientific discourses can be harnessed by a female author, and permeate non-scientific mediums – and the novel at this time was considered especially “prattling.” As Lewes had written: “the Masculine mind is characterized by the predominance of the intellect, and the Feminine by the predominance of the emotions . . . the very nature of fiction calls for that predominance of Sentiment which we have already attributed to the feminine mind” (“Lady Novelists” 132-3). *The Mill on the Floss*'s response to the Astronomer's Provocation is to show that astronomy, and science writ large, do not belong only in “high towers.” The logic of astronomy and geometry operate in spaces outside of the classroom, in relationships, and in novels: or, what Tom calls “girls stories.”

## Notes

1. The example Eliot refers to and translates reads: “. . . ut *as*, *astrónomus an astrónomer exósus háting mulíeres women ad únam (mulíerem) to one, that is, in géneral.*” *The Eton Latin Grammar* (242).

2. For biology and Eliot, see: Gillian Beer, *Darwin's Plots* (137-95); and Mark Wormald, “Microscopy and Semiotic in *Middlemarch*.” For Eliot and astronomy, see: Sally Shuttleworth, *George Eliot and Nineteenth-Century Science* (176-80); and Anna Henchman, *The Starry Sky Within* (158-95). For Eliot and science more generally see: Tess Cosslett, *The 'Scientific Movement' and Victorian Literature* (74-100); Ian Duncan, “George Eliot's Science Fiction”; Jules Law, *The Social Life of Fluids* (98-124); George Levine, *Dying to Know* (171-99); Alan Rauch *Useful Knowledge* (190-202); Sally Shuttleworth, *George Eliot and Nineteenth-Century Science*; and Brooke D. Taylor, “The Science of Fiction in *Daniel Deronda*.”

3. Conversely, Jonathan Crary argues “from the beginning of the nineteenth century a science of vision will tend to mean increasingly an interrogation of the physiological makeup of the human subject, rather than the mechanics of light and optical transmission” (70). Isobel Armstrong uses Victorian examples, however, to show that the latter issues were still of concern (272-316).

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