INTRODUCTION
Part A: The Historical Question

1. GALILEO'S CHALLENGE

On November 24, 1679, Robert Hooke wrote a friendly letter to Isaac Newton in Cambridge. It was partly ex-officio: Hooke has just been nominated to be the secretary of the Royal Society, succeeding his recently-deceased nemesis Henry Oldenburg, and in his new capacity was responsible for the Society's correspondence. But it was not all formal; he was clearly glad of the opportunity. Hooke had long suspected Oldenburg of inciting Newton, among others, against him, and the relations with Newton were important to him. Still bitter, perhaps, over the outcome of the reflecting telescope dispute[1], Hooke nevertheless required Newton's already-famous mathematical savvy in order to help him realize an idea he had been nurturing for over thirteen years, an idea which he had published and submitted to other mathematicians with so far no avail (Nauenberg, "Hooke," 336; Lohne, "Hooke versus Newton," 13-15).

Hooke had every reason to be both proud and frustrated. His idea provided a clear and straightforward path towards solving a fifty-year old challenge: *to account for the heavenly motions in the terms Galileo used in his treatment of terrestrial mechanics*. Without overlooking Kepler's first valiant attempts at *Physica Cœlestis*, this challenge was posed by Galileo himself, in the Fourth Day of his *Discorsi* (Galileo, *Dialogues Concerning Two New Sciences*. Henceforth: *Discorsi)*. Evidently, Galileo had only a vague notion of how to solve this problem, for he refrained from letting his hero, Saliviati, reflect on it. Instead, in the midst of a discussion on the subject of gravity and violent motion combining to produce a parabolic path, he placed in Sagredo's mouth a remark concerning

> the beautiful agreement between this thought of the Author and the views of Plato concerning the origins of the various speeds with which the heavenly bodies revolve.[2] (*Discorsi*, 261)

While we can judge the importance and difficulty of unpacking this "beautiful agreement" by the number and eminence of the scholars entranced by it, the sheer variety of approaches suggests that none were deemed satisfactory. Thus, in approaching Newton, Hooke wasted little space on the social niceties before presenting his request. "I shall take it as a great favour" he wrote,

> if you will let me know your thoughts of that [hypothesis of mine] of compounding the celestiall motions of the planetts of a direct motion by the tangent & an attractive motion towards a central body (Newton, *The Correspondence* II, 297. Henceforth: *Correspondence*).

This is the essence of "Hooke's Programme," as it later became known: to account for the revolutions of the planets as a rectilinear motion encurved by an attraction to the center about which they revolve.

2. The Correspondence

2.1. November 24, 1679

Hooke may have thought that this succinct presentation, combined with his previous publications on the subject, would suffice Newton to grasp his *Programme*. The *Programme* indeed makes stringent demands regarding the theoretical tools it prescribes; but one might have thought that after Descartes, such austerity would not appear inordinate. Still, as I will show in Chapter 1, none of those whose fingerprints appear on *Hooke's Programme* has actually considered the planetary orbits as the outcome of curving rectilinear motions. For Kepler as well as Galileo, for Descartes himself, as well as for Gassendi and the Cartesians Mersenne and Huygens, for that venerable departed genius Horrox as well as for Newton's own favorite Borelli, the explication of the planetary motions had always included rotation as a primary cause. And Newton indeed failed, on first sight, to appreciate either this particular trait of *Hooke's Programme* or its general potential.

Yet he did not snub Hooke's advances, and the ensuing correspondence, which spanned eight weeks during the winter of 1679/80, adds up to a fascinating document. It is compact—comprised of four letters by Hooke and two by Newton—and intense—the intervals between them are just enough for the London mail to reach to Cambridge (and *vice versa*). It is embedded in a well-defined social context; the network of public correspondence established by the late Oldenburg and revolving around the flourishing Royal Society, but it also registers a charged and intense encounter between two people with complex personal relations. It has a clear and explicit epistemic end; to enlist Newton's "excellent method" to solve "the celestial motions of the planets" as it was captured in Hooke's workshop, but the conjunction of Hooke's and Newton's complimentary skills and talents is more than simple collaboration. The communication between the reclusive Newton and the suspicious Hooke entails crafted structures of personal trust and intellectual respect beside subtle means of fending off the open and entrepreneurial social setting. The creation of common grounds for their differing, indeed almost incompatible conceptions of matter, force and motion, does not exclude rhetorical maneuvers of careful positioning towards future disputes over credit and authority. The correspondence is indeed a prime example of a "social process of negotiation situated in time and space" (Knorr-Cetina, *The Manufacture of Knowledge*, 152).

2.2. November 28, 1679

Here, however, I shall have to suffice it with brief consideration of those parts of the correspondence pertaining directly to the *Programme*[3]. As mentioned, its first reception by Newton was lukewarm. Genuinely or not, he replied on November 28 by denying that he had ever "so much as heare (yt I remember) of [Hooke's] Hypothesis of compounding ye celestial motions of ye planets, of a direct motion by the tangt [sic.] to ye curve" (*Correspondence* II, 300). Yet, since Hooke discusses planetary motion and mentioned a demonstration of the annual motion of the earth, Newton contributes to the discussion a suggestion for an experiment to demonstrate its diurnal, *i.e.* west to east motion. One of the traditional anti-Copernican arguments had been that if the earth rotates around its axis (from west to east, or from *B* towards *G* in Figure 1), then objects detached from the earth—projectiles, clouds, birds—should be 'left behind' and fall to the west of their point of departure. On the contrary, suggests Newton: if one was to release a stone from a high enough tower *BA*, it would always fall to the *east* of the tower—towards point *D* in the diagram he includes. At point *A* at the top of the tower the stone is further from the center *C* of the earth rotation than at the bottom of the tower *B* is, hence its motion to the east is quicker. Since, as taught by Galileo, the motion downwards does not affect the motion eastward, the stone would continue traveling east as it falls down and would meet the ground "quite contrary to the opinion of ye vulgar" (*Correspondence* II, 301), at point *D* to the east of the tower.

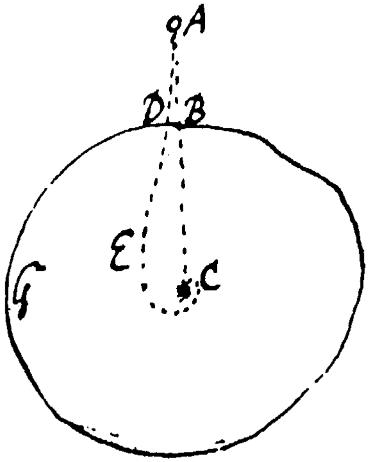

Figure 1: Newton's diagram from his November 28, 1679 letter to Hooke (Lohne, "Hooke Versus Newton," 9). The stone at the top of the tower (A) falls to the east (D) of the bottom of the tower (B). If allowed to continue through the earth, it will spiral through E until reaching the center of the earth (C).

2.3. December 9, 1679

Hooke responded, almost as promptly, on December 9. Not only did he like the experiment very much and promised to carry it out—he was, after all, the curator of experiments for the Royal Society—but a note in Newton's letter allowed him to redirect the discussion to his Programme. The diagram which Newton appended to his experimental suggestion (Figure 1) had a little speculative addendum to it, describing the hypothetical motion of the falling stone if it were to continue, resistance-free, through the earth: in this case, suggested Newton, it would fall through point *E* and spiral around its center *C* a few times, until coming to rest in *C*. This alluded exactly to the point Hooke was trying to make—the compounding of motion along the tangent with attraction to a center—and he was only too happy to set Newton right: "supposing then ye earth were cast into two half globes in the plane of the equinox and those sides separated at a yard Distance" (*Correspondence* II, 305), so that the stone could fall through it while still experiencing the attraction towards the center, it would not describe a spiral, but an "Elleptueid." Namely: like the planets, "the line in which this body would move would resemble an Ellipse" (*ibid.*) such as *AFGHA* in the diagram Hooke provides (Figure 2). This planetary orbit-like ellipse will collapse into spiral *AIKL etc.*—terminating in the center *C*—only if the stone encounters a resisting medium as it falls. Again, these are the most basic elements of Hooke's "Theory of Circular motions compounded by a Direct motion and an attractive one to a center" (*op. cit.,* 306).

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