***G. W. Leibniz, Sämtliche Schriften und Briefe, Dritte Reihe : Mathematischer, Naturwissenschaftlicher und Technischer Briefwechsel.* Dritter Band 1680-Juni 1683, bearbeitet von H. Breger. Berlin: Akademie-Verlag, 1991, lix+896 pp.**

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(Translated by Glenn A. Hartz[1])

The 483 pieces that comprise the work (letters, accounts of conversations, reconstructions of lost letters) come complete with five indexes. One is a valuable index of correspondents including, for each one, biographical information; there are indexes of names of towns cited in the correspondence, of proper names, of works cited, and of things. The notes systematically establish the ties between different works and point out all the references to works alluded to.

The work reassembles an impressive series of documents, a minute examination of which would allow one to reconstruct, almost from day to day, a chronicle of Leibniz's various activities and interests. Among the 62 correspondents, a good number are physicians, chemists, economists (notably Johann Daniel Crafft), even entrepreneurs and other business men, to whom Leibniz recounts anatomical and barometric observations, observations on the declination of the magnet, on construction of thermometers, on recent books—also secrets, cures, and all kinds of news. For example, there is a letter connected with managing the Harz mines—in particular, with the construction (supported by drawings) of windmills for removing water. It is remarkable to rediscover the problematic that Jon Elster considers in his *Leibniz et la formation de l'esprit capitaliste* as the central problem—namely, obtaining a constant source of energy—appearing as follows: (1) at the heart of a question on anatomy discussed with physician Heinrich Meibom. (2) In discussions of the fact that the triangular form of certain vessels (Lat. *vas*), being farthest from circular form, allows them to change sufficiently to expel a continuous stream of liquid, even though the liquid does not come into them continuously. (3) In notes Leibniz took on a conversation following a correspondence with Dutch mathematician Johann Jakob Ferguson, on the way of determinants and resources for different systems of numeration. (4) In correspondence with the obstinate Noël Douceur, who won't give up, for the promised sum, his "secret" for making soft iron — on which Leibniz obviously remained sceptical, despite the favorable testimony of Mariotte. (5) In a few exchanges with some *Royal Society* members. These are purely formal, except for a letter to Theodore Hook, which contains some reflections on the characteristic (which R. Hooke will call "algebra of algebra") and some allusions to the fruitfulness of diophantine arithmetic and to research on the prime numbers, offered to Detlev Clüver. (6) In some letters to Parisian personalities—not least important, Leibniz writes to Colbert to show him the fossils found in the Harz. Then to Father La Chaise, confessor of Louis XIV, he presents his *Analysis situs*, suggesting that his characteristic project would presuppose the cooperation of a society of scholars. (7) In an exchange with the editors of *Acta Eruditorum*, notably Christoph Pfautz, about placing Leibniz's leading contributions in the new review (which appeared in 1682): that is, the arithmetic quadrature, the unique principle of optics, the juridico-mathematical meditation on interest.

Emerging from this vast collection, some salient traits and clues of scientific interest are immediately apparent. For instance, there are the methodological reflections on applying geometry to physics, assuming an ordering of experiences. Another theme from the methodological reflections is the imperfection of cartesian geometrical analysis, which serves as the framework and justification for the vast project of the geometric characteristic. Presented to Huygens with a certain enthusiasm (but also with this not totally disinterested goal in mind—to find support for his Academy of Sciences), the latter, in the end, gathers nothing but a sceptical reception. Huygens complains not only about the promising declarations, but also about concrete examples of application; it led to nothing but a complete misunderstanding.

The correspondence with Mariotte (with whom Leibniz is quite close to falling out as a result of the continual schemes of Noël Douceur!) places us in the presence of a range of very important physical questions: the resistance of solids surrounding an intensive discussion on the Galilean problem of a fixed beam in a wall, the resistance of air posed in terms of the mechanics of fluids, capillary attraction ("the water is a bit sticky" he points out to Mariotte), the problem of the continuity of degrees of speed, the nature of colors (according to Leibniz, a color must have its origin in refraction). In the correspondence with (and concerning) Tschirnhaus at the time of the latter's sojourn in Paris, we can follow step by step Leibniz's progress in understanding the caustic curves (curves formed by reflection of light rays on a concave spherical mirror) dear to the latter. In an astonishing letter to Mariotte (of 14 May 1682), Leibniz begins by declaring that he doesn't understand the problem clearly and considering that the place of all intersections must form, not a line, but a whole plane. Then, a few lines below, Leibniz finds in the differential calculus a method of construction that will constitute one of the most beautiful applications of the new calculus: indeed, he says that one can find a point on a caustic curve by the intersection of two infinitely close light rays. Then, "*d'un coup d'esprit*," he catches sight of the remarkable properties of this curve, tangential to a family of laws, and also its "considerable uses." This intuition, under which all the "curves of development" will fall, will become that of an envelope of a family of curves. Still, the most palpable reflection that this volume allows in reconstructing these advances is perhaps that which Leibniz develops (in fact redevelops, since he claims they are already elaborated in old rough drafts) for Günther Christoph Schelhammer (doctor of medicine and professor of botany at Helmstedt), who is working on a treatise on hearing (*De auditu*, 1684). Indeed, it is a new acoustic theory, whose interest lies not only in its connections with great intuitions of Leibnizian physics, but also in giving us the key to certain philosophical developments.

Sound is not produced by percussion but by the shaken bodies' vibratory reaction ("*itiones et reditiones*"). No body is silent, for each maintains some elasticity, even if certain "tones" are imperceptible. The characteristic of the air that allows sounds, whatever their pitch, to be transmitted, is to be the "*homotone*" for all the possible tones. This condition is conceivable only through the capacity of diverse parts of the same volume of air (a fluid divisible to infinity) to transmit many springs of elasticity, several independent vibrations. A part of a body can thus have a state of vibration different from that of the whole. Thus is explained this magnificient secret of nature: the capacity of air to transmit not only sound but "tone."

But this remarkable property of the homotone must be equally a property of the ear. Leibniz sees that its different parts can agree on different "tones" by the muscles' action of accommodation, as in the mechanism of accommodation in the pupil: "we must explain how the organ can get in unison with all the given sounding bodies, that is, how the eardrum produces exactly a degree of tone; perhaps it takes for itself the tension that it needs by means of the muscles. Just as we know that the parts of the eye take on proper shape for better seeing ...." says Leibniz in summing up his theory for Mariotte (who has just presented a paper to the Academy of Sciences on the structure of the inner ear). The organ of hearing should thus be compared to "cords of sympathy" (dear to the 18th Century) that are able, in certain musical instruments, to join in the vibration without contact. This subtle theory constitutes not only a general undulatory model of the *expression* of sensory qualities, but also of their memory conceived as an echo. It explains the "blind doors" of sensation—allowing for hearing with the teeth (*New Essays* II iii)—and finds an echo in *Monadology* 25.

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