Henry Cavendish

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May 19-25, 2017

I do not know when I first heard of Cavendish. At Christmas 1963 I got a popular book on Chemistry, Physics and Astronomy, and I thought for a long time that this must have been the source for my first knowledge of him but consulting the book in connecting while writing this review I find no trace of him inside. The encounter must have been later, during the years that followed I read many popular books on science, but I recall that when I did read about him, his extreme taciturnity made a deep impression on me, and not without some element of horror, I thought of him as a possible 'soulmate', maybe he was a previous incarnation. Since then he has intrigued me, after all he was the one who managed to experimentally find the gravitational constant (which for astronomical reasons is not that crucial) or what is equivalent, measuring the density of the Earth (which admittedly is more interesting than its weight). Recently I was alerted to the fact that Cavendish was a very skilled experimentalist, and that in addition much of what he had done, he had not bothered to publish, thus anticipating a fair amount of 19th century physics and chemistry. That he was also one of the richest men in England, although living a life of utmost personal frugality, added to the fascination. Thus I looked up a possible biography of the man on Amazon and found a used one, which turned out to have been an old, very dusty smelling, discarded library copy (libraries are in general unseemingly eager to divest their holdings) stemming from 1960. One may at the back of the book look at the records of the times it was borrowed, as the costums were in the past, and discover that it was stamped four times in 1961, six further times later in the 60's, and three times in 1974. I guess after that interest flagged and eventually it was considered as of no interest. Unfortunately, books do in general have shelf lives.

The dust jacket of the book is illustrated by supposedly the only likeness of Cavendish in existence, and the one repeatedly used. He refused to sit for a portrait, and the sketch was done surreptitiously by an artist invited to a meeting [1] at the Royal Society, showing him in telltale dress which was already out of fashion at the time. Only the first chapter is devoted to something resembling a biography of the man, the author excuses himself with so little being known, and so little to be found in documentation, indicating that the man was a hermit of sorts. This is, however, misleading; not the one for small talk, he was not entirely adverse to society, provided it was on his own conditions. For one thing he did regularly attend the weekly meetings of the Royal Society, at which he took an active part. He was not devoid of friends, but typically those were very few, two or three at the most; on the other hand one suspects that the relations were if not excessively intimate unwaveringly loyal and of long duration stemming from youth, the ideal time when to forge lifelong friendships. With people to whom he had no personal ties, he exhibited

[1] A certain William Alexander (1767-1816), and the actual sketch is a watercolor of very modest size preserved at the British Museum

extreme shyness, it is rumored that he had a special staircase built, as to avoid having to run into his maid, having a perverse horror of women. He travelled but sparsely, and then always in pursuit of some scientific exploration, never for idle pleasure, being indifferent to natural beauty, and beauty in general, his scientific equipment never marked by any elegance only devoted to pure functionality. He bequested his extensive holdings, not to science, but to his relatives, maybe because for reasons of loyalty, after all the riches which came his way, and never bestowed any pleasure to him, excluding those of comfort and freedom from worries (after all he would not need to apply for research grants and had no pressure to publish unless pleasure to do so impended him), originated from his family, to which he thus owed allegiance. His life was fairly long by the standards of the days (1731-1810) and in spite of his terseness of publications a very productive one. In fact the author claims him to be one of the foremost scientists of his age, a worthy successor of Newton. This certainly applies to Newton as an experimentalist, but the contributions of Cavendish as a theoreticians are more modest. It was Lavoisier who explained the process of combustion, thereby killing the old theory of phlogiston, to which Cavendish formally adhered. Phlogiston was a strange element assumed to have negative weight! Which goes to show that the old chemists were willing to go to some counter intuitive lengths, but if in the writing of Cavendish, phlogiston is replaced by negative oxygen, the findings of his turn out to be correct. Thus hydrogen was a combination of water and phlogiston, and thus indeed we have $H_2O + (-O) = H_2$ in modern terminology.

The book's plan is as follows: after an initial biographical chapter, there follows a rather insightful chapter on the status of science at the time of Cavendish and its naturem to be followed by separate chapters on specific aspects. Thus we have a special chapter on Cavendish as a chemist, his forte being his very careful quantitative experiments, as well as one on his discovery of water as being a composition of oxygen and hydrogen from 1784 which embroiled him in priority disputes with Watts and Lavoisier, and to which the author accords his subject the laurels. Two chapters are devoted to his electrical researches, which may have been the most impressive, and had he published more, his standing as a scientist in the eyes of posterity would have been much higher. In particular he explained how the torpedo fish might store electricity and as a result being able to impart electrical shocks. He also did experiments on heat, establishing the basic properties on the temperature on mixing solutions of different ones. If they are the same substances, it is a question of a simple arithmetical mean, otherwise you need to take into account different specific heats and thus establish ways of measuring them[2]. He was also interested in meteorology and made many time sequences of observations. What he may be most known for is his experimental determination of the gravitational constant, which was equivalent with establishing the density of the earth (more interesting than its mere weight as noted above). This amounted to measuring actual gravitational attractions between small bodies of known weight and was a real challenge to his ingenuity as an experimentalist. He rose

[2] This might appear tautological, but the challenge is to establish coherence, such as transitivity of the ratios of different specific heats, each indicated by experiment. Thus if mixing first A, B, then B and C, the result of mixing A and C would be predictable in an immediate way. In fact if the ratios are given as α, β, γ we should have $\gamma = \alpha \cdot \beta$.

to the challenge and produced a value reasonably close to the modern one[3].

The bulk of the biography is thus focused on his scientific work, the full extent of which did not become known until his *Nachlaß* was closely examined in the 19th century. One of those who studied it was the famous Maxwell acquiring a deep admiration for him. The exposition is, however, not that illuminating and hence somewhat unsatisfactory, at least at parts. What is needed is not only to describe what Cavendish did, but to explain why it was interesting and to set it into context. Cavendish was, as noted, a master experimentalist, but in what ways did he stand head and shoulder above his contemporaries. It is in the details the devil is to be seen, but the details are not enough, the reader needs to be guided to what is significant and where his gaze should be focused.

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[3] Other attempts were made by using some mountain, with a god estimate of density and thus weight and see how much it affected the direction of the load line.