Maxwell–Thomson–Loschmidt reversal

Descriptions of the recent demonstration of time-reversed waves mimicking instantaneous reversal of motion in a fluid[1,2] emphasized their connection with Loschmidt's 1876 paper[3]. Some readers may be surprised to learn of other closely related publications earlier in the 1870s also considering the consequences of instantaneous motion reversal. William Thomson presented the better-known of these at a meeting of the Royal Society of Edinburgh on 16 February 1874[4,5] and in a news piece for *Nature* on 9 April 1874[6]. An earlier discussion was given on 15 January 1874 in James Clerk Maxwell's anonymous review of Balfour Stewart's textbook *The Conservation of Energy*[7]. (External and internal evidence supports Maxwell's authorship of the book review[8,9].) After noting the reversibility of "pure dynamics" Maxwell indicates[7] "If then at a given instant, every particle of the Universe were to have the direction of its motion reversed so as to start anew with an equal but opposite velocity, everything would run backwards from the end to the beginning. We might attempt a description of a world thus recoiling upon itself — the rivers running up into the hills, heat flowing from cold bodies to hot, and men passing over the stage of life from their graves to their cradles …" He then goes on to remark "Now why is this state of things, though dynamically possible, physically absurd? Simply because it requires the exact reversal of the motion of every atom in the Universe. If but one atom were to receive a velocity differing infinitesimally from an exact reversal, that atom would leaven the whole Universe with that tendency to dissipation of energy which actually exists, and things would go on as they now do."

Maxwell perhaps anticipated ongoing issues related to chaos theory while ignoring the relevance of time scales[10]. Thomson's interest in the implications of instantaneous motion reversal may not have been independent of Maxwell's. Among Maxwell's miscellaneous printed items archived in the Cambridge University Library (MS.Add.7655/Vi/12) is a newspaper report of Thomson's presentation (*The Edinburgh Courant*, 17 February 1874) containing pencilled margin notes and textual revisions. That is not surprising since Thomson had included a detailed discussion of attributes of Maxwell's demon. Thomson also considered "deviations from absolute precision in the reversal" with an emphasis on a lack of fidelity when the number of molecules becomes "practically infinite"[4,6]. Irrespective of the early history, the consequence of motion reversal remains relevant in modern research[1,2,10]. ❐

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