

REVIEW ARTICLE

CORRECTING THE RECORD: PRIORITY AND THE EINSTEIN PAPERS ON “BROWNIAN MOTION”

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Late in the nineteenth and early in the twentieth century, the prominent Australian physicist William Sutherland (1859-1911) was interested in explaining the diffusion by random motion of small particles suspended in liquids – a motion earlier noted by Scottish botanist Robert Brown in 1827 and thereafter denoted in his honor as “Brownian Motion.”

In 1904, applying a dynamical approach, Sutherland derived an equation for the physical processes underlying Brownian motion by mathematically explaining the diffusion of a solute into a solvent, based on fundamental atomic and molecular models relating diffusion to viscosity. His discovery was reported in a paper given at the 1904 Australasian Association for the Advancement of Science conference at Dunedin, New Zealand and subsequently published in the *Philosophical Magazine* in early 1905¹ (Sutherland, 1905).

¹ A list of Sutherland’s extensive body of work is listed at Tim Sherratt and Victoria Young, *Physics in Australia to 1945: SUTHERLAND, William*, WWW Bright Sparcs, June 1995 edition, The University of Melbourne eScholarship Research Centre 2007. Accessed 2 Oct. 2018, Available from <http://www.asap.unimelb.edu.au/bsparcs/physics/P000814p.htm>.

Correspondence between Einstein and his life-long engineer friend Michele Besso in 1903, reveals a keen interest in Sutherland's work. (Rothman, 2006; Stachel, 1989, p. 213) Some months after Sutherland's publication, but also in 1905, Einstein published exactly "the same equation," and as "having arrived at it by exactly the same line of reasoning," (Home and others, 2004)² but without acknowledgement of a debt to, or even the existence of, Sutherland's prior work. (Einstein, 1989)

For his part, Einstein claimed in 1906 that it was as a result of his 1905 paper that his attention was first drawn to the fact that experimental identification of Brownian motion had been published as early as 1888.³ Einstein historian Gerald Holton also cites Einstein as writing later that his work of 1905 was undertaken "without knowing that observations concerning Brownian motion were already long familiar," (Einstein, Autobiographical Notes, cited in Holton, 1960, pp. 629-30) – a claim which may be thought to sit awkwardly with his prior and extensive interest in Sutherland's work. It is to be further noted that a discussion on 1888 reports on Brownian motion by French physicist M. Gouy, is contained in Poincaré's *Science et hypothèse*, (p. 179) which, as noted by Maurice Solovine, Einstein and his 'Academy' friends had read and studied with particular relish. (Stachel, 1989, p. 211) Nonetheless, although some still desire to allow the Einstein work as independent, Abraham Pais, in his classic biography of Einstein, suggests that, at least in the interests of natural justice, the result should be known more correctly as the "Sutherland-Einstein" equation. (Pais, 1982, p. 92)

Putting aside the specter of plagiarism in the interests of reducing unpalatable and unproductive speculations, I would submit that asserting a Sutherland claim to priority in both discovery and publication of the Brownian motion formula for

² In his 1900 doctoral thesis, "The Theory of Speculation", which deals with random fluctuations of the stock market, French economist, Louis Bachelier advanced the same equation construct, but defining stochastic elements of economic theory. Bachelier also anticipated the "Black-Scholes" approach to options trading and earned the title "father of mathematical finance" (Rothman, 2006, p. 112) It is also of note that in 1906, and independently of Sutherland and Einstein, Polish scientist Marian von Smoluchowski, also published a theoretical description of Brownian motion: "*Zur kinetischen Theorie der Brownschen Molekularbewegung und der Suspensionen*," (*Annalen der Physik*, 1906, vol. 326, Issue 14, pp 756-780.)

³ After his attention had been drawn to prior works, Einstein's second paper on Brownian motion, in 1906, cited only the observations reported by M. Gouy in 1888 as discussed by Poincaré, and then only as being experimental confirmation of his own conclusions. (Stachel, 1989, p. 211)

physical phenomena and adopting the Pais suggestion as to its name, is the very least we should feel obliged to do, both in the interests of natural justice and the probity of the history of science.

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Stachel, John, 'Einstein on Brownian Motion', in John Stachel, David C. Cassidy, J. Renn, and Robert Schulmann (eds.), *The Collected Papers of Albert Einstein - The Swiss Years: Writings, 1900-1909*, vol. 2, Princeton University Press, 1989, pp. 210-22.

Sutherland, William, 'A dynamical theory of diffusion for non-electrolytes and the molecular mass of albumin', *Philosophical Magazine*, vol. S.6, no. 9, 1905, pp. 781-5.

Of William Sutherland, the *Encyclopedia of Australian Science* says in summary:

Educated University of Melbourne (BA 1879, MA 1883) and University College London (BSc 1881). Private coaching; examiner, University of Melbourne; acting lecturer in natural philosophy, University of Melbourne 1888, acting professor 1899; regular contributor to the *Melbourne Age* from 1901, especially on scientific topics. Undertook theoretical investigations, chiefly in the field of molecular dynamics; the results were published as 78 scientific papers, mostly in major international journals. His model, the Sutherland model, assumed that the particles of which matter is composed exert an attractive force on each other (now known as the 'Sutherland potential') in addition to gravity. He also studied the dependence of the viscosity of a gas on its temperature, developing a formula which included a constant for any particular gas that is now called Sutherland's Constant.

SELECTED ARTICLES IN SUTHERLAND'S PUBLISHED BODY OF WORK,
SOME, AND POSSIBLY ALL OF WHICH ALBERT EINSTEIN MAY HAVE
READ AND FOUND INTERESTING:

"The causes of osmotic pressure and of the simplicity of the laws of dilute solutions".

Philosophical Magazine, S.5, 44 (1897), 493-498

"The molecular constitution of water". *Philosophical Magazine*, S.5, 50 (1900), 460-489.

"The cause of the structure of spectra". *Philosophical Magazine*, S.6, 2 (1901), 245-274.

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