

# This Week's Citation Classic

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**Dungey I W.** Interplanetary magnetic field and the auroral zones.  
*Phys. Rev. Lett.* 6:47-8, 1961.

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Hoyle<sup>1</sup> suggested that the primary auroral particles are accelerated at neutral points in the combination of an interplanetary field and the geomagnetic field. A field model is developed which is confirmed by the observed  $S_D$  current system. Assuming the interplanetary field to be roughly southward, the field and flow are sketched in the noon-midnight meridian plane, but the topology of the field is also needed and is described. For a steady state, the electric equipotentials are mapped to the polar ionosphere and a sketch shows positive potential over the dawn auroral zone and negative potential at dusk, thus fitting with  $S_D$ . It is concluded that there is an approximately southward field. [The  $SC1^{\circ}$  indicates that this paper has been cited in over 460 publications since 1961.]

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"The origin of this paper conformed to the classic model. The publication was precipitated by a flash of vision, but this was preceded by 13 years of intermittent headscratching, conscious and subconscious. My wife thought I would go bald. The flash came in the classic way, while preparing a talk, in a classic place: I was sitting at a sidewalk café in Montparnasse. This was the post-Sputnik period and accounting of research contracts was much less stringent than now. The address on the publication is Pennsylvania State University, who paid me consulting fees for work I did at home. The Meudon Observatory paid me to sit in a café and they got the oral presentation, but I chose to write it for Penn State, and I enjoyed my consultancy for another seven years.

"My involvement began in another classic place, Cambridge, England, where, in 1947, Fred Hoyle gave me a tough, but rewarding, thesis project. While observing solar flares, Giovanelli had conceived the idea that mag-

netic neutral points were crucial, and I was to develop this idea and apply it to the aurora. Giovanelli was in Sydney and, during my postdoctoral fellowship there, he was extremely kind to me both in my work and generally. My thesis in 1950 contained the essential of what I later called 'reconnection' and one major step in the application to what was later called the 'magnetosphere.' Each part can be encapsulated by a diagram and Figure 1 of my *Citation Classic* paper is one of the magnetospheric diagrams of my thesis, though it was never previously published. It is a section in the noon-midnight meridian plane, and in my thesis I did not explore elsewhere. One reason against publishing was the rejection of my reconnection paper by the Royal Astronomical Society, though it was published in the *Philosophical Magazine*.<sup>2</sup> More important was that I could not relate the model to any observation, though I sought throughout the 1950s for something to fit. I wrote a monograph, but only briefly mentioned the idea without any diagram. The flash was the visualisation of the model in three dimensions showing immediately the fit with what is called the ' $S_D$  pattern' in my *Citation Classic* paper and is now known as 'convection.'

"Initially, the reconnection model seems to have been regarded as an entertaining fiction, but a prediction was successful and a controversy developed. I was enlightened by someone who was planning to make a movie about the magnetosphere and had visited most of the experts. He told me people got very emotional about reconnection. One can speculate whether it would have been accepted more easily without my *Citation Classic* paper, so that experimentalists could have discovered it. Reconnection remained out of favour throughout the 1970s, but improved observations with the International Sun-Earth Explorers swung opinion the other way. This is written as I fly back from a conference, where the opposition was described as a vocal minority. The proceedings<sup>3</sup> will provide an up-to-date survey.

"The reasons for citation of this paper must be a mixture of controversy and the growth of the subject. When I receive the conference proceedings,<sup>3</sup> I will analyse any further citations in them."

1. Hoyle F. Magnetic storms and aurorae. *Some recent researches in solar physics*.

England: Cambridge University Press, 1949, p. 102-4.

2. Dungey I W. Conditions for the occurrence of electrical discharges in astrophysical systems. *Phil. Mag.* 44:725, 1953.

3. Hones E W, Jr., ed. *Magnetic reconnection*. Washington, DC: American Geophysical Union.

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