



The Ring Current's Birth and Development: A Conceptual History

Alv Egeland (1) and William J. Burke (2)

(1) Department of Physics, University of Oslo, Norway, (2) Boston College, Institute for Scientific Research, Chestnut Hill, MA, USA

This talk outlines how our understanding of the ring current evolved during the half-century intervals before and after humans gained direct access to space. Its existence was first suggested by Kristian Birkeland in 1908 – based on his terrella simulations, and later postulated and confirmed in 1910 by Carl Størmer, to explain the locations and equatorward migrations of aurorae under disturbed conditions. In 1917 Adolf Schmidt applied Størmer's ring-current hypothesis to explain the observed negative perturbations in the Earth's magnetic field. More than another decade would pass before Sydney Chapman and Vicenzo Ferraro - in early 1930s, argued for its necessity to explain magnetic signatures observed during the main phases of storms. Simultaneously, Ernst Büche extended Birkeland's terrella experiment with an equatorial electric current that could be turned off or on to demonstrate the latitudinal movements of the aurorae.

During the early 1950s Hannes Alfvén first correctly argued that the ring current was a collective plasma effect, but failed to explain the particle entry. In 1957 Fred Singer proposed a ring current model for the main phase of storms that combined Alfvén's guiding-center drift with Størmer's forbidden regions. The Dessler-Parker relation explains that the observed magnetic perturbations are proportional to ring-current energy. In the mid-1960s Louis Frank showed that ions in the newly discovered plasma sheet had the energy needed to explain the ring current's origin. The discovery that O⁺ ions from the ionosphere contribute a large fractions of the ring current's energy content still challenges scientific understanding.