

## BIRKELAND'S PIONEERING STUDIES OF GEOMAGNETIC DISTURBANCES

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At the beginning of the 20<sup>th</sup> century Kr. Birkeland (1867-1917) addressed questions that had vexed international scientists for centuries. Why do auroras appear overhead when the Earth's magnetic field is disturbed, as discovered by Hiorter and Celsius in 1741. How are magnetic storms connected to disturbances on the Sun? To answer these questions Birkeland interpreted his advance laboratory simulations and extended his well coordinated campaigns in the Arctic wilderness in the light of Maxwell's newly discovered laws of electricity and magnetism. His analysis of thousands of world wide magnetic records resulted in the classification of geomagnetic disturbances into the following three categories:

1. Polar elementary storms. These disturbances are now referred to as "polar substorms", although Birkeland's nomenclature is more logical.
2. Equatorial perturbations. These disturbances correspond to the initial and main phases of magnetic storms.
3. Cyclo-median storms. Birkeland was the first to recognize this type of variation.

He also first published the global, two-cell pattern of electric currents in Earth's upper atmosphere, nearly 30 years before the ionosphere was discovered. Birkeland's most enduring contributions to the physics of geomagnetic disturbances were his recognition of *Birkeland currents* needed to couple ionospheric phenomenon to interplanetary space. This conclusion has profound and had far reaching significance for understanding the origin of geomagnetic currents. Birkeland's discoveries will be compared with modern terminology. Many of his ideas were misinterpreted and dismissed for decades, only to be vindicated when satellites could fly above the Earth's atmosphere. He even proposed as the source "negative charged corpuscles from the sun" in 1896, two years before the electron was discovered.

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