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Bjerknes, Carl Anton

(*b*. Christiania [later Kristiania, now Oslo], Norway, 24 October 1825; *d*. Kristiania, 20 March 1903)

mathematics, physics.

Bjerknes was the son of Abraham Isaksen Bjerknes, a veterinarian, and Elen Birgitte Holmen. Both of his parents were of peasant stock, and throughout his life Bjerknes retained strong ties to his relatives in the country. The father, who as the youngest son did not inherit any land, died in 1838, leaving his widow and three children in straitened circumstances. In 1844 Bjerknes entered the University of Christiania and completed his undergraduate studies in 1848 with a degree in mining engineering. After several years at the Kongsberg silver mines (1848–1852) and as a mathematics teacher (1852–1854), he was awarded a fellowship that enabled him to study mathematics in Göttingen and Paris (1856–1857). The lectures of Dirichlet made a great impression on him and turned his interest to hydrodynamics, which later became the main subject of his research.

In 1859 Bjerknes married Aletta Koren, daughter of a minister. Two years later he was appointed lecturer in applied mathematics at the University of Christiania and was promoted to professor in 1866; in 1869 the professorship was converted to a chair of pure mathematics.

Bjerknes had a delightful personality and was an excellent teacher who was greatly respected by his students for his personal qualities and outstanding lectures. As the years passed, however, he showed an increasing tendency to professional isolation and a fear of publishing the results of his research, which was concerned mainly with hydrodynamic problems. Apart from the very close cooperation with his son Vilhelm, he lived for the most part in his own world. At one point Vilhelm had to extricate himself from this collaboration in order to avoid the danger of unproductive isolation. Nevertheless, in many fields he contributed to the elucidation and continuation of his father's theories.

Bjerknes had been particularly impressed by Dirichlet's demonstration that, according to the principles of hydrodynamics, a ball can move at a constant speed and without external force through ideal (frictionless) fluids, i.e., without the fluid's offering resistance to the ball's movement. Earlier, he had been greatly influenced by Leonhard Euler's *Letters à une princesse d' Allemagne*, in which Euler opposed the concept of certain forces, such as Newtonian gravity, which are presumed to work at a distance rather than through an overall encompassing medium or ether. One of the strongest objections to the ether theory had always been the difficulty in understanding that according to the principle of inertia, a body not influenced by force should be able to move through such a medium without resistance, but in his lectures Dirichlet had proved that this was possible for movements in the frictionless fluids of hydrodynamics.

Slowly, Bjerknes developed the notion that it was possible, on the basis of hydrodynamics, to form a general theory of the forces active between the solid elements and the influence of the forces on the movements of those elements. First he studied the movement of a ball of variable volume through frictionless fluid according to the method of mathematical physics, and was thus led to further calculations of the simultaneous movements of two such balls. In this way he arrived at the historical conclusion, in 1875, that two harmoniously pulsating balls moving through frictionless fluid react as though they were electrically charged, i.e., they attract or repel one another with a force similar to that of Coulomb's law: they repulse one another when performing harmoniously pulsating oscillations in opposite phases (i.e., when one has maximum volume and the other's volume is minimal); conversely, they attract each other when oscillating in the same phase, thus attaining maximum or minimum volume at the same time.

This important discovery was followed by a number of tests that further stressed the analogy between the movement of bodies in frictionless fluids and the phenomena of electrodynamics. This research, which Bjerknes carried out in collaboration with his son, was substantiated by experiments that drew considerable attention at the electrical exhibition held in Paris in 1881.

Bjerknes' goal was now to develop this analogy to include Maxwell's general theory for electrodynamic phenomena, but despite his intensive efforts he did not attain this goal. His "hydrodynamic picture of the world" and his efforts to explain the electromagnetic forces through hydrodynamics are today more a fascinating analogy than a basic physical theory, yet through this research Bjerknes attained a great insight into hydrodynamic phenomena and thus anticipated later developments in several fields. It is especially noteworthy that through his efforts to describe the action of a magnetic field on an electric current he came to the conclusion that a cylinder rotating in a moving fluid is influenced by a force of the type that today is known as the hydrodynamic transverse force.

Shortly before his father's death Vilhelm Bjerknes published a work on long-range hydrodynamic forces as formulated in his father's theories. In it he explains and clarifies the important results of his father's research.

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