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Harry Petschek and the Universality of Magnetic Reconnection

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Magnetic reconnection, considered an exotic and singular process when first proposed, is recognized today as a phenomenon of fundamental significance and widespread applicability in numerous contexts for plasmas in space, astrophysics, and the laboratory. This change of attitude was to a large extent made possible by the two principal insights of Harry Petschek: that the spatial extent of the indispensable non-ideal region need not be set by the size of the system but can adjust itself, taking much smaller values, and that the entire reconnection process can be formulated as a flow problem, with waves, discontinuities, and boundary conditions. The first insight allows a reconnection rate that is large enough to be interesting, making magnetic reconnection the prime candidate for explaining observed explosive releases of energy in solar flares or magnetospheric substorms. The second provides a way of describing magnetic reconnection as a universal process, applicable within a great variety of geometrical and dynamical configurations. Correspondingly, current understanding can be described under two broad topics which derive from the two insights. One is concerned with the physics of deviations from ideal MHD that are required for reconnection and with the local structure and dynamics (particularly conditions for instability) of the non-MHD regions. The other is concerned with the global aspects, in particular the questions: what configurations and boundary conditions result in the ocurrence of magnetic reconnection, on either quasi-steady or dynamical time scales, and what determines the reconnection rates. Although the concept of magnetic reconnection is now widely invoked, there is still no complete consensus on the two related questions: how is it defined, and what are its observational signatures?