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From Plasma to Complex Plasma

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Earlier research on plasma turbulence and later research development on a complex plasma are discussed. Study of nonlinear evolution of instabilities in a collisionless plasma, especially ion acoustic instability and Buneman instability, revealed the role of plasma collective modes in the heating of plasma particles. It was essential for plasma waves to grow in time, resulting in the heating of plasma itself through effective interaction of plasma particles and plasma waves. Theoretical study revealed the time constant for the heating to occur in a plasma. When plasma instabilities are well developed and spread wide in frequency range, the plasma turbulence caused the broadening of wave-particle resonance region. The earlier plasma experiments tried to eliminate any impurities from the vacuum chamber to guarantee the experimental conditions as much as ideal theoretical bases. However, the onset conditions of plasma instabilities are found to be modified in the presence of dust particles, micron in size and negatively charged. The presence of dust particles is found to modify the effective temperature of electrons, resulting in the suppression of the Landau damping. Furthermore, the dust plasma, now known as a complex plasma because of the nature of complex system as a composite of plasma particles and dust particles, is found to be rich in fundamental novel physics including a strongly coupled state and the anomalous nature of electromagnetic propagation in the medium. Dust particles when placed in a sheath interact each other in the presence of ion flow and produce a line along the flow. The paired chain was interpreted as a pair-formation by the exchange of phonons. The dust particles could be floated at the sheath edge producing a one- or a two-dimensional lattice structure, which provides a platform for the study of low-dimensional behavior of Coulomb systems. Some of the current topics of a complex plasma are discussed.

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