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Kinetic and hydrodynamic models of the solar wind: a review

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Following the publication of the first models of solar wind and solar breeze a debate tends to pit magnetohydrodynamic oriented scientists against holders of a more kinetic description, particularly regarding the mechanisms by which ions and electrons evaporate from the solar corona. In this talk we present a review on kinetic and fluid models of the solar wind. We first discuss the theoretical background starting from the fundamental Boltzmann equation. We briefly review several types of solutions: Hilbert-Chapman-Enskog expansion, expansion about a local Maxwellian (fluid or moments or Grad method), expansion about an absolute equilibrium. The exospheric kinetic models of the solar wind are then discussed as a direct application of the general theory. We show that kinetic models provide velocity distribution functions of the solar wind electrons and ions different from drifting and displaced Maxwelians or bi-Maxwelians as postulated in hydrodynamical formalism. It is shown that fluid models have the same theoretical "roots" as kinetic ones. We review the complementarity between kinetic and fluid approach and illustrate model results for comparison with experimental data.