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Kinetic modeling of active plasma resonance spectroscopy[1]

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The term "active plasma resonance spectroscopy" (APRS) refers to a plasma diagnostic method which employs the natural ability of plasmas to resonate close to the plasma frequency. Essential for this method is an appropriate model to determine the relation between the resonance parameters and demanded plasma parameters. Measurements with these probes in plasmas of a few Pa typically show a broadening of the spectrum that cannot be predicted by a fluid model. Thus, a kinetic model is necessary.

A general kinetic model of APRS probes, which can be described in electorstatic approximation, valid for all pressures has been presented [1]. This model is used to analyze the dynamic behavior of such probes by means of functional analytic methods. One of the main results is, that the system response function $Y(\omega)$ is given in terms of the matrix elements of the resolvent of the dynamic operator evaluated for values on the imaginary axis. The spectrum of this operator is continuous which implies a new phenomenon related to anomalous or non-collisional dissipation. Based on the scalar product, which is motivated by the kinetic free energy, the non-collisional damping can be interpreted: In a periodic state, the probe constantly emits plasma waves which propagate to infinity. The free energy simply leaves the observation range of the probe which is recorded as damping.

The kinetic damping, which depends on the mean kinetic energy of the electrons, is responsible for the broadening of a resonance peak in the measured spectrum of APRS probes. The ultimate goal is to determine explicit formulas for the relation between the broadening of the resonance peak and the "equivalent electron temperature", especially in the case of the spherical Impedance Probe and the Multipole Resonance Probe.

[1] J. Oberrath and R.P. Brinkmann, Plasma Scources Sci. Technol. **23**, 045006 (2014).

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