§14. Application of Wave Momentum to a Nonneutral Plasma and its Contribution to Transport

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Indefinitely long confinement of an ion plasma has been achieved in a Malmberg trap with the application of a rotating RF [1]. The key process of the *rotating wall* has been pointed out by Hollmann *et al.* as the penetration of the RF field in Trivelpiece-Gould (TG) mode[2]. A theory tells that the addition of the wave momentum to the (negative) canonical angular momentum of the plasma system leads to a reduction of the radial distribution of the particles[3]. However, it may not provide a full account of the process and many aspects remain unsolved in spite of abundant physical significances involved.

Following preliminary results in the previous year's experiments, we have carried out a series of wave propagation analyses coupled with high resolution observation of the density profiles of a pure electron plasma showing dynamic response to the applied wave. Main achievements in the FY2003 may be summarized as follows[4]:

(1) The radial compression of the density distribution is observed under the rotating m=1 RF field as low as 25mVp-p across the 64mm apart wall antennas.

(2) This observation encouraged the authors to develop a new and fast numerical scheme of correlation analysis for weak wave signals. Analog data processing was unable to provide a sufficient level of S/N for physical analysis.

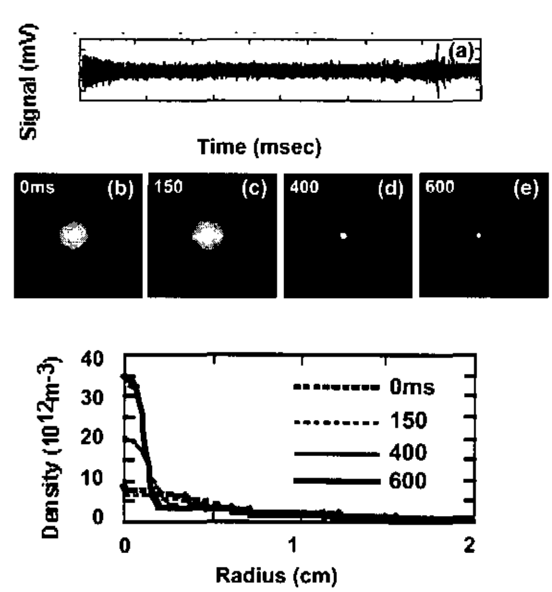
(3) The frequency of the RF is linearly ramped up typically from 0.1 to 1.4MHz in 600ms as shown in Fig.1. The density distribution is compressed even while the received signal is below the detectable level as long as the launched frequency lies within the propagation band of TG mode.

(4) During a rapid compression phase of the density profile there appear strongly enhanced levels of detected waves as seen around 550ms in Fig. (a). Once enhanced the frequency of the detected wave remains there while the driving frequency moves linearly upward so that the correlation function exhibits an oscillation corresponding to the frequency difference.

(5) In some cases not clearly identified, there appear enhanced waves shifted by the diocotron frequency (~40kHz) below the driver frequency.

(6) While the time-resolved density profile shows a symmetric compression, as shown in Figs.(b)-(e), we have noticed some occasions that low-density halos electrons appears and expand outward when the spiky signals are detected.

(7) The on-going numerical analysis of the TG eigen-modes incorporating the observation –based time-dependent profiles of the electron density suggests that the emergence of oscillations in the correlation function may correspond to transitions between TG modes with different radial nodes.



Reference

1) F. Anderegg, E. M. Hollmann, C. F. Driscoll, Phys. Rev Lett.. **81**, 4875 (1998).

2) E. M. Hollmann, F. Anderegg, C. F. Driscoll, Phys. Plasmas, **7**, 2776 (2000).

3) Roy. W. Gould, ***Non-Neutral Plasma Physics III***, ed. by John J. Bollinger *et al.* 170, AIP (1999).

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