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Laboratory realization of an ion-ion hybrid Alfvén wave resonator[1]

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In a magnetized plasma with two ion species, shear Alfvén waves (or guided electromagnetic ion cyclotron [EMIC] waves) have zero parallel group velocity and experience a cut-off near the ion-ion hybrid frequency ω_{ii} [1]. Since the ion-ion hybrid frequency is proportional to the magnetic field, it is possible, in principle, for a magnetic well configuration to behave as an Alfvén wave resonator in a two-ion plasma. The important role played by the wave cut-off at $\omega = \omega_{ii}$ in determining the structure of low frequency wave spectra has long been recognized in space plasma studies. For instance, Temerin and Lysak [2] identified that the narrow-banded ELF waves seen in the S3-3 satellite were generated by the auroral electron beam in a limited spatial region determined by the local value of ω_{ii} for a mix of H^+-He^+ ions. In addition to playing a key role in magnetospheric resonators, EMIC waves and the existence of multiple ion species are also important in the scattering of high-energy electrons in the earth's inner magnetosphere [3]. The present study demonstrates [4] such a resonator in a controlled laboratory experiment (in the Large Plasma Device at UCLA) using a H^+-He^+ mixture. The resonator response is investigated by launching monochromatic waves and sharp tone-bursts from a magnetic loop antenna. The topic is also investigated theoretically, and the observed frequency spectra are found to agree with predictions of a theoretical model of trapped eigenmodes. Results of the experiment and theory will also be discussed in their relation to the ion-ion resonator feature proposed for planetary magnetospheres [5-6] and to magnetic confinement devices containing multiple ion species [7].

[1] Vincena, S. T., G. J. Morales, and J. E. Maggs, Phys. Plasmas, 17, 052106 (2010)
[2] Temerin, M, and R. L. Lysak, JGR, 89, 2849 (1984)
[3] Meredith, N. P., R. M. Thorne, R. B. Horne, D. Summers, B. J. Fraser, and R. R. Anderson JGR 108(A6) (2003)
[4] Vincena, S.T., Farmer, W.A., Maggs, J.E., and Morales, G.J., GRL, 38, L11101 (2011)
[5] Guglielmi, V. A., A. S. Potapov, and C. T. Russell, JETP Lett., 72, 298 (2000)
[6] Mithaiwala, M., L. Rudakov, and G. Ganguli, JGR, 112, A09218 (2007)
[7] Intrator, T., M. Vukovic, A. Elfimov, P. H. Probert, and G. Winz, Phys. Plasmas 3 (1996)

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