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Gyroresonant interactions between the radiation belt electrons and whistler mode chorus waves in the radiation environments of Earth, Jupiter, and Saturn: A comparative study

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In the current study we perform a comparative analysis of the gyroresonant interactions of whistler mode waves with radiation belt electrons in the magnetospheres of Earth, Jupiter, and Saturn. Our primary goal is to evaluate the effect of resonant wave-particle interactions with chorus waves and determine whether chorus waves can produce net acceleration or net loss of radiation belt electrons on the outer planets. The ratio of plasma frequency to gyrofrequency is a key parameter that determines the efficiency of the pitch angle and energy resonant scattering. We present a comparison of statistical maps of the ratio of plasma frequency to gyrofrequency for Jupiter, Saturn and Earth in terms of radial distance and latitude. Preliminary maps of the plasma frequency to gyrofrequency ratio and 2D simulations of pitch angle and energy diffusion using the Versatile Electron Radiation Belt (VERB) indicate that the Kronian plasma environment is not likely to support as efficient gyroresonant interactions with whistler mode chorus waves as in the Terrestrial or Jovian environments. Inefficiency of the local acceleration by whistler mode waves in the Kronian environment raises important questions about the origin of the relativistic electrons in the Saturn's radiation belts. Two-dimensional diffusive simulations of local acceleration and loss to the atmosphere using the VERB code confirm previous suggestions that the acceleration of electrons may be very efficient in the outer radiation belt of Jupiter. However, sensitivity simulations also show that the result of the competition between acceleration and loss in the Jupiter's magnetosphere strongly depends on the currently unknown latitudinal distribution of chorus waves that will be provided by the upcoming Juno mission. If waves extend to high latitudes, it is likely that the loss rates due to whistler mode waves will exceed energization rates.