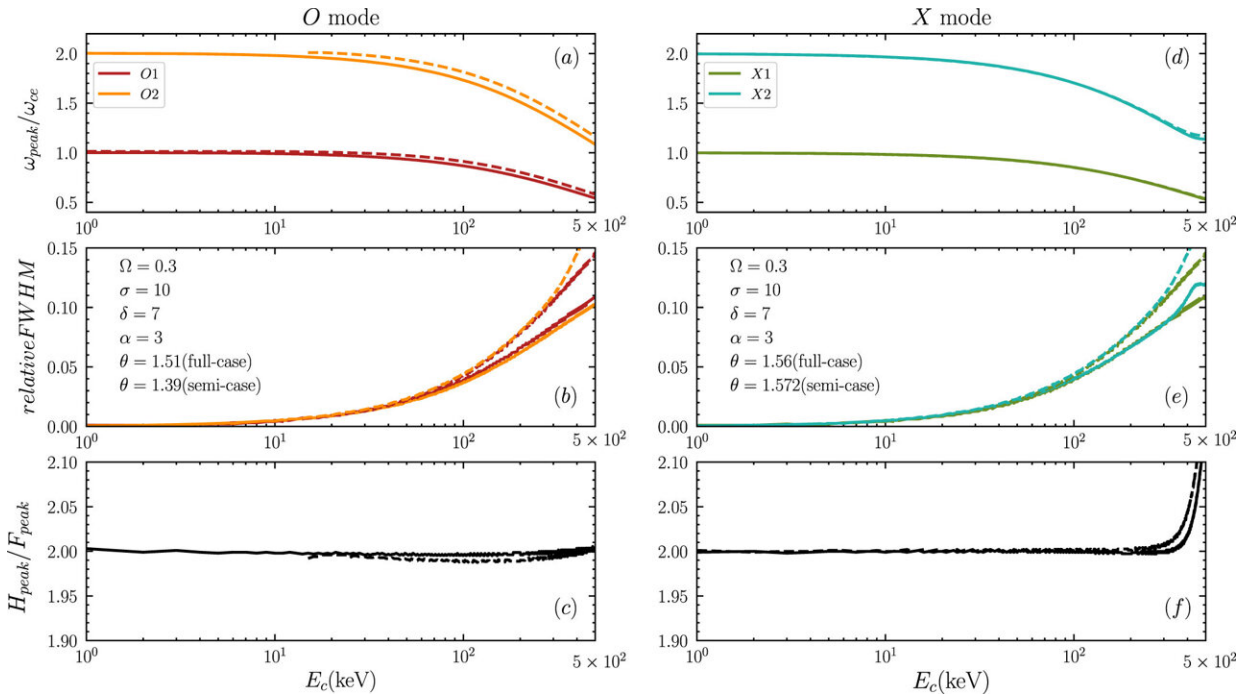
Researchers explore effects of fully relativistic condition on electron cyclotron maser emission

March 31 2023, by Li Yuan



Peak frequency ω_{peak}, relative frequency FWHM $\omega_{width}/\omega_{peak}$, peak frequency ratio between the harmonic and fundamental frequency H_{peak}/F_{peak} vs. cutoff energy E_c : O1 (2), fundamental (harmonic) waves in the O mode; X1 (2), fundamental (harmonic) waves in the X mode; solid and dashed lines denote the "full case" and "semicase," respectively. Credit: *The Astrophysical Journal* (2023). DOI: 10.3847/1538-4357/acaef9

Radio emission, carrying a wealth of information, is critical for understanding the physical process of various outbursts. The electron cyclotron maser emission (ECME) plays an important role as a coherent radiation mechanism in explaining radio emission phenomena from celestial bodies.

Currently, most studies on ECME only consider the relativistic effects of resonance conditions, i.e., semi-relativistic corrections. However, when ECME is used to explain strong radio burst events that are produced by relativistic electrons, it is necessary to consider the influence of fully relativistic effects on the theory.

Researchers from the Xinjiang Astronomical Observatory (XAO) of the Chinese Academy of Sciences and their collaborators conducted a preliminary study on ECME with fully relativistic correction, and found that the ECME case with fully relativistic correction has a greater advantage in exciting the ECM instability when non-thermal electron energy was above 50 keV.

The results were published in *The Astrophysical Journal* on Feb. 10.

The researchers found that the fully relativistic correction had a larger instability growth rate and a smaller peak frequency compared with the semi-relativistic case. The fully relativistic correction effects were important only in the case with energy above 50 keV, and the semi-relativistic ECM was still a good approximation for the lower-energy case. For strong magnetic field environment, the X mode cutoff frequency could be lower than its peak frequency.

Moreover, the radio emission from pulsars, flare stars and Blazar jets usually has extremely high bright temperatures, which suggests that cyclotron maser instability must be involved. Therefore, it is necessary to consider fully relativistic correction for ECME to understand these

high-energy radio emissions.

More information: Lijie Zhang et al, Effects of Fully Relativistic Condition on Electron Cyclotron Maser Emission, *The Astrophysical Journal* (2023). DOI: 10.3847/1538-4357/acaef9

Provided by Chinese Academy of Sciences