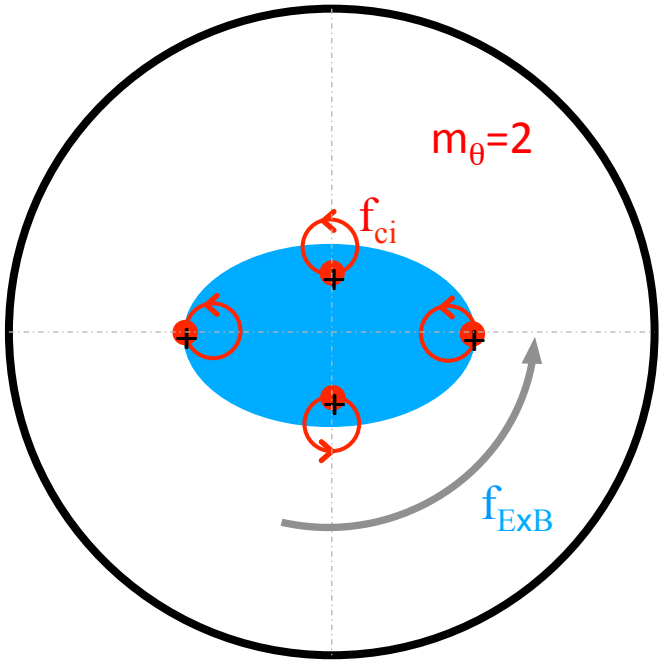
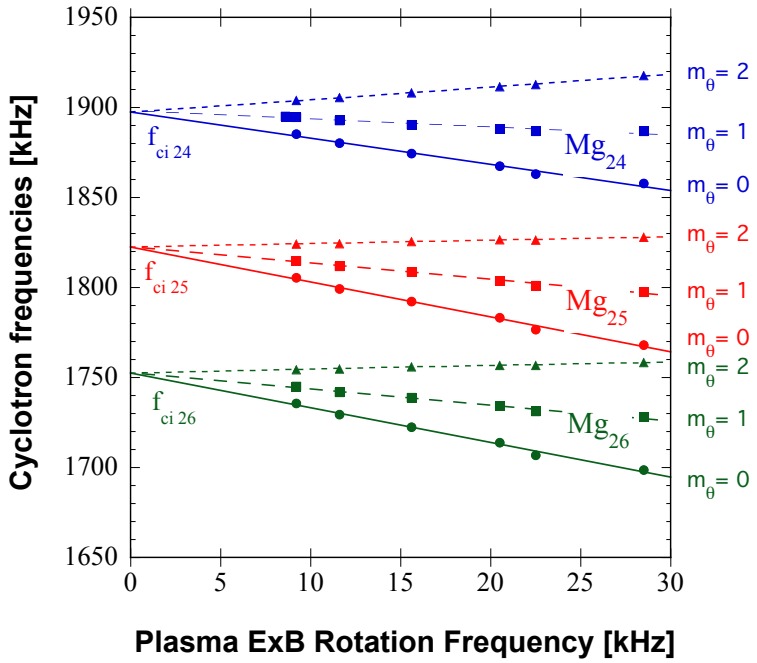
Driscoll /Dubin/O'Neil, UCSD

Cyclotron Modes in Multispecies Ion Plasmas



Plasmas exhibit a variety of cyclotron modes, and electric fields shift the mode frequencies away from the "bare" cyclotron frequencies $2\pi f_{ci} = q_i B/m_i$. Recent theory (Dubin 2013) gives precise predictions of these shifts, for the "regular" m_θ=1 (center-of-mass) mode, and for the unusual m_θ=2 (cartoon shown) and m_θ=0 modes. For a species of fraction δ_i, the shift is given by $f_{ExB}\,[\, m_\theta - 2 + \delta_i\,(1-\mathcal{R})\,]$, where f_{ExB} is the ExB drift rotation frequency, and $\mathcal{R}$ represents image charge corrections from R_{wall}.



A new laser-thermal cyclotron spectroscopy technique (Affolter 2013) gives the first quantitative measurement of these shifts. The figure shows m_θ=0, 1, 2 modes for Mg isotopes 24, 25, 26. The novel m_θ=0 mode has no radial electric field, and thus couples only at the ends. A theory fit to the data shown gives the three $\phi_{\chi\iota}$ to an accuracy of 2 parts in 10^4. These new results may be relevant to "space charge" and "amplitude" calibrations for cyclotron mass spectroscopy devices widely used in molecular chemistry and biology.