Acceleration towards the standing-wave node near the cyclotron frequency

A. Fruchtman[1], G. Makrinich[1]

[1] *H.I.T. – Holon Institute of Technology, Holon, Israel*

The trajectory of an ion under the forces by the wave electric and magnetic fields of a planar standing wave and a steady uniform magnetic field normal to the wave plane are studied. The frequency of the wave is close to the cyclotron frequency of the ion in the steady magnetic field. One effect is the well-known first-order-in-the-wave-field ion cyclotron resonance heating (ICRH). ICRH is analyzed here for a uniform steady magnetic field instead of for a resonance layer in a nonuniform field. A second effect that we focus on here is the ion acceleration along the steady magnetic field, an acceleration that is second-order in the wave fields; the wave magnetic field plays a crucial role. Ions tend to accelerate by the ponderomotive force towards the nodes of the wave. The direction of the acceleration depends on whether the cyclotron frequency is larger or smaller than the wave frequency. We discuss the advantages and difficulties in using this process for mass separation. The ions tend to oscillate around the wave node. It is shown that if the wave frequency is not too close to the cyclotron frequency, the particle motion is periodic in a ponderomotive potential; the ion axial kinetic energy is determined by its location. When the wave frequency is closer to the cyclotron frequency, the ion motion ceases to be periodic. The particle oscillates around the magnetic wave node with a varying oscillation frequency and with a varying velocity amplitude, the trajectory being governed by the Mathieu equation. Numerical and analytical results are presented.