Electromagnetic (EM) waves in plasma influence the dynamics of planetary magnetospheres and affect the cosmic environment in orbital regions of man-made satellites. In this thesis, we present space physics applications of the ray tracing method as a tool for studying the propagation of plasma waves in the approximation of geometrical optics. Based on a simulation in cold plasma approximation we explain observed and unexpected changes in the wave vector direction of quasiperiodic waves measured by the low-orbit satellite DEMETER. We also studied, with the use of a hot plasma ray tracing code developed as a part of this thesis, the behavior of chorus emissions in the Earth's outer magnetosphere, focusing on the possible ducting of these whistler mode waves and the evolution of wave magnetic energy. We show that large portion of chorus emissions observed by the Cluster spacecraft must be ducted and conclude that while the linear theory cannot fully explain observed wave growth, it can make up a large portion of the observed increase in energy in the low and mid-latitudinal regions. Lastly, we present propagation characteristics of EM proton cyclotron waves in the water-ion rich magnetosphere of Saturn and we show that in contrast to observations in the Earth's magnetosphere, a direct observation of left-polarized proton cyclotron waves in the equatorial region of the Saturn's magnetosphere is unlikely.