

2. A radio source (say a pulsar), a distance  $d$  from Earth (typically hundreds of light years), simultaneously emits two radio pulses, one at a frequency  $\omega_1$  and the other at  $\omega_2$ , with  $\omega_2$  larger than  $\omega_1$  by a little. If the interstellar medium contains  $N$  free electrons per unit volume (and the same number density of free protons), what is the difference in arrival times, at the Earth, of the two pulses? Which one arrives earlier? You should assume that  $\omega_1, \omega_2 \gg \omega_p$ , where  $\omega_p$  is the plasma frequency of the medium.