S11 PHY114 PROBLEM SET 10

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1. A radio telescope, whose two antennas are separated by L , is designed to receive radio waves of frequency f produced by astronomical objects. The received radio waves create electronic signals in the telescope's left and right antennas. These signals then travel by equal-length cables to a centrally located amplifier, where they are added together. The telescope can be "pointed" to a certain region of the sky by adding the instantaneous signal from the right antenna to a "time-delayed" signal received by the left antenna a time ago. (This time delay of the left signal can be easily accomplished with the proper electronic circuit.) Find the time delay if the object t be viewed is at an angle θ to the vertical.

2. Stealth aircraft are designed to not reflect radar, whose wavelength is typically 2 cm , by using an antireflecting coating. Ignoring any change in wavelength in the coating, estimate its thickness.

3. A radar speed detector works by reflecting microwaves off a car and measuring the change in the frequency. If waves of frequency $4 \times 10^{10} Hz$ are measured to be 2×10^3 Hz lower in frequency after reflection, what is the speed of the car? Is it moving away or towards the speed detector?

4. An X-Ray photon has an energy of 124 keV. What is its wavelength?

5. A radioactive isotope has half-life of 9 months. After three years what fraction of this isotope will be left?

6. A 3 MeV gamma ray is emitted by a lead nucleus. By how much is the mass of the nucleus reduced?