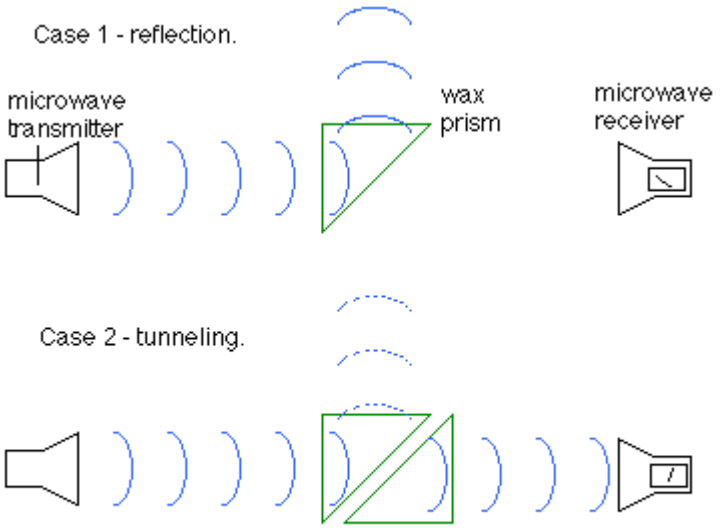
Modern physics ** 7A50.20 ** Quantum effects

Wave mechanics

Microwave barrier penetration



With two wax prisms separated by a small air gap, the microwaves tunnel through the gap and are picked up by the receiver.

Equipment:

- Microwave emitter and receiver - shelf 9D
- support rod for above - shelf 9D
- two large wax prisms- shelf 9D
- projection meter for the overhead - shelf 9D
- lab jack

Warning: Be careful not to aim the microwaves at the students, and try to minimize your own exposure.

Theory: Classically, the expected result is that 100% of the incident beam is reflected at the interface In practice, however, some of the beam will tunnel across a small air gap. The gap should be comparable to the wavelength; with a frequency of 10.5 GHz the wavelength is 2.86 cm. This frustrated total internal reflection is analogous to the quantum tunneling of particles out of a potential well.

Description: Arrange the emitter and receiver on the support rod, with the emitter facing the receiver and the horns aligned. Check to see that the receiver registers a signal; the projection meter can be plugged into the receiver and the meter reading displayed on the overhead projecter. When one wax prism is introduced into the beam the microwaves will be reflected. The receiver reads zero at the straight-through position, and a large reading when placed in the path of the reflected beam. When the second prism is introduced with a small (but appreciable...up to 5 cm) air gap, the microwaves will tunnel across the gap and can be picked up by the receiver in the straight-through position.

Setup time: 15 minutes

References: (available in the demo room)

- Meiners, "Physics Demonstration Experiments", 38-6.6, page 1188.