Home experiments with radio and television signals

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Adapted from http://tap.iop.org/. Used with permission.

You need access to some or all of the following:

- TV set with indoor aerial
- TV with aerial on the roof
- FM radio with aerial on roof
- portable radio, preferably AM and FM

NB A top quality FM radio is very good at preventing you hearing the effects of bandwidth or of noticing fading as waves are reflected onto the aerial, because it has automatic frequency and volume control. The result is that poor signals are made as good as possible until they are lost altogether. Use the cheapest portable radio possible for this investigation!

What do I need to do?

As many of the investigations suggested below as you can (if you have the right stuff), and time and your interest allows.

What do I need to hand in?

At least, one A4 side (preferably more) with your notes on the investigations you did and your observations. Don't forget units for estimates / calculations and labelled diagrams of what you saw!

Radio Spectrum

- Do you have a portable FM radio with dial rather than push-button tuning? If so, spin the dial and notice the frequencies at which stations come up **write these down**.

  Typical frequencies are in the range 90–100 MHz or so. The strong signals will not be closer than 0.2 MHz apart. Notice the range of frequencies over which you can still hear a strong signal as you tune the radio 'through' its frequency. It may be about 0.1 MHz either side of the correct frequency. That 'bandwidth' allows for the variations in frequency produced by the radio waves carrying the audible signal.

  You may get less strong stations, generally ones meant to be picked up somewhere else, very close to the frequency of one of your local stations.

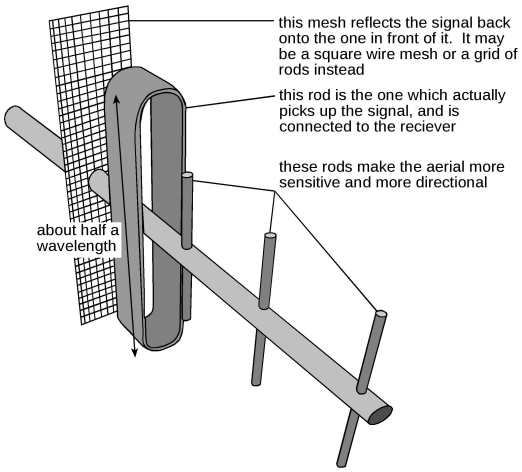
- Does your FM radio have push-button tuning? If so, there is probably a 'Search' button which runs up or down the frequency scale, stopping when the radio detects a signal. Use this to **find the frequencies of stations** as above. If there is a Fine Tuning control, try that to see the spread of frequencies over which you can still hear a station.

- If you have an AM radio, **try locating stations** on the medium wave band. How does their quality compare to that of FM stations? Again, over what range of frequencies can you tune and still hear the station? How does it compare to the range for FM? Are there examples of stations too close together which you hear one on top of the other?
- Finally, **calculate the wavelengths** for some FM and AM stations.

Indoor and outdoor aerials

SAFETY Do not to delve into high-voltage equipment or to climb on roofs to get a better look at aerials!

- Do you have a TV with an indoor aerial? It may be a loop of wire, or it may be some metal rods. Measure the approximate dimensions of the aerial—the length of the rods or the diameter of the loop. Working on the rule of thumb that the wavelength is often about twice the dimensions of the aerial, estimate the frequency of TV signals. Does your estimate put the frequency in the UHF band 300 MHz to 3 GHz?
- Turn the aerial around with the TV switched on. Does the picture vanish or get faint in any direction? Is it best in some other direction? You may be able to guess the direction of the TV transmitter from this.
- Do you have a TV aerial on the roof, or can you see someone else's roof aerial? Look for something like this:



  If there is more than one such aerial, the one for TV is the one with the shortest rods. The rods may be vertical or horizontal. The aerial points towards the TV station. Estimate the length of the rods, top to bottom (look for something like chimney bricks whose size you know to guess the length).
- Use the rule of thumb that the wavelength is about twice the full length of the rods, to estimate the wavelength. Does your estimate put the frequency in the UHF band of 300 MHz to 3 GHz?

- Now look for FM radio aerials on the roof. They look like the TV aerials but the rods are longer and there are usually only a few of them. Again estimate the wavelength from a guess at the length of the rods, and see if that puts the frequency in the FM band around 90 to 100 MHz. At least notice the difference in size between TV and FM radio aerials, because of the difference in wavelength.

- Is there a TV satellite dish on a house near you which you can get a look at? No need to touch! Offset from the centre of the dish is the collecting aerial, inside a covered tube. Knowing that satellite frequencies are somewhere in the SHF 3 GHz to 30 GHz band, what wavelengths might they have? How many times bigger than the wavelength is the dish diameter? Why would that be?

- Also, think about where the satellite must be, having noticed that the collecting aerial is not quite on the axis of the dish.

  Not all aerials are of the order of a wavelength in size. Mobile telephones have short stubby aerials yet use frequencies in the region of 900 MHz, wavelength around 300 mm.

Polarization

- Look again at TV and FM aerials on a roof, if you can see any. Notice whether the rods are vertical or horizontal.

  The aerials with vertical rods are for stations that send out electromagnetic waves polarized vertically. The horizontal rods detect waves that are polarized horizontally. This can be used to stop stations getting in each other's way if they use frequencies close together, since one aerial is bad at detecting signals with the opposite polarization. Next time you make a railway journey, look at the aerials on roofs in big towns some distance apart: are they lined up for opposite polarizations?

- You may be able to use an indoor TV rod or loop aerial to detect polarization too. Find the station direction by pointing the aerial to get a good signal, and then turn it around that axis. Does the picture get better or worse?

Waves adding together

- It's common with an indoor TV aerial to find that the picture depends on where the aerial is in the room, and where people are near it. Try putting the aerial down and walking around it. Does the picture come and go? If so, notice how far you move between places where the picture is good and bad.

  The waves bounce off your body and add to those going direct to the aerial. This can make the picture better if the direct and reflected waves are in step when they get to the aerial. But if they are out of step, peak to trough and trough to peak, they add together to give less than either alone. With waves, more can be less.

- If you have a portable FM radio and are near a large wire fence (perhaps round a school or park) you can try and see whether you can get the FM signals reflected from the fence to enhance or reduce the signal at the radio. Try walking towards and away from the fence, carrying the radio. Don't expect any effect for movements of less than about half a wavelength, say around 1.5 m.