Radio telescopes in deserts, optical telescopes in deserts, and X-ray and gamma-ray telescopes in space. Astronomers go to great lengths to capture electromagnetic radiation. But why?

Light from each part of the electromagnetic spectrum gives insights into different physical processes going on in stars and galaxies. For example, optical light, at wavelengths of hundreds of nanometers,

can show us where energy is being emitted by hot objects, like stars.

If we do a large survey of the sky in optical light,

we see images of hundreds of galaxies and also hundreds of stars within our galaxy. If we do a large survey of the sky at radio wavelengths, we see little black blobs. Each little black blob here is a distant radio galaxy. The radio emission we see is typically coming from jets and lobes emitted by the accretion disk around the supermassive black hole at the centre of the galaxy. We call these active galactic nuclei.

Now say you've carried out both of these surveys, and you want to know which of these active galactic nuclei are located in which of these optical galaxies? Which of these measured objects correspond to the same physical one? We know that supermassive black holes play a central role in regulating star formation, but how they do it is a major unanswered question. To investigate questions like this, we need to combine optical and radio information.

To combine this information and, hence, build a more complete picture of the galaxy, we need to match the objects in the radio survey with the objects in the optical survey. The way we usually do this is to create a catalogue of objects from each survey, and then do a **positional cross-match.**

**Accretion Disk of a Black Hole:** Material, such as gas, dust and other stellar debris that has come close to a black hole but not quite fallen into it, forms a flattened band of spinning matter around the event horizon called the accretion disk (or disc). Although no-one has ever actually seen a black hole or even its event horizon, this accretion disk can be seen, because the spinning particles are accelerated to tremendous speeds by the huge gravity of the black hole, releasing heat and powerful x-rays and gamma rays out into the universe as they smash into each other.

**Active galactic Nuclei:** An **active galactic nucleus** (**AGN**) is a compact region at the centre of a galaxy that has a much higher than normal luminosity over at least some portion of the electromagnetic spectrum with characteristics indicating that the luminosity is not produced by stars. Such excess non-stellar emission has been observed in the radio, microwave, infrared, optical, ultra-violet, X-ray and gamma-ray wavebands. Active galactic nuclei are the most luminous persistent sources of electromagnetic radiation in the universe, and as such can be used as a means of discovering distant objects.

References: <https://www.physicsoftheuniverse.com/topics_blackholes_event.html>

<https://youtu.be/e-P5IFTqB98>

<https://en.wikipedia.org/wiki/Active_galactic_nucleus>