Active Galactic Nuclei and the Dusty Torus

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1. Introduction

The term Active Galactic Nuclei or AGN are some of the most luminous objects in the universe and can be found at the centre of about 10% of large galaxies. The term itself refers to the supermassive black hole and the structure around it.

Black holes are objects which are so dense and heavy that nothing, not even light can escape from them. They are so heavy that they change the way space and time behave around them. Supermassive black holes are found at the centre of galaxies and are at least a million times the mass of our Sun.

If the supermassive black hole is accreting (growing through mass falling into it) then it is said to be active. The structure around the black hole is made up of an accretion disc which feeds the black hole and a dusty torus (or doughnut) which surrounds the accretion disc and the black hole. The accreting black hole, accretion disc, and torus can be described as the Active Galactic Nucleus.

Figure 1: An artist's impression of the Active Galactic Nucleus of NGC 3783. Image credit: ESO/M. Kornmesser.

2. The Dusty Torus

The torus is made up of gas and tiny grains of graphite, like you would find in a pencil. If the grains of graphite get too hot (1200°C), they will change from a solid to a gas in a process known as sublimation. Where this happens is called the Sublimation Radius.

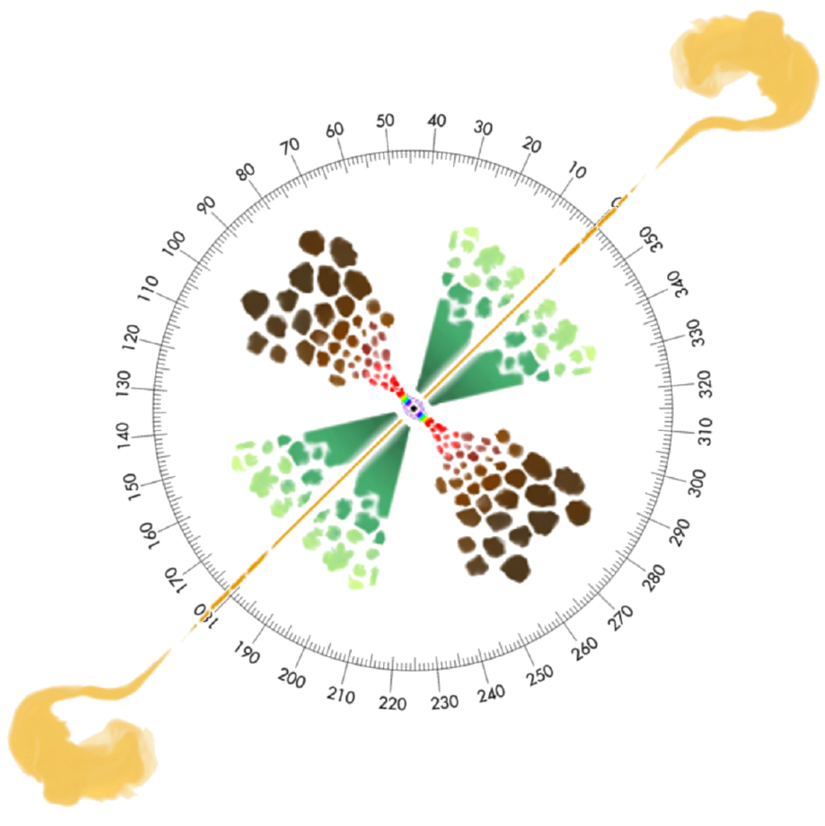

Figure 2: A diagram of an AGN which shows the dusty torus in brown and the accretion disc at the centre in multiple colors. In red and green are areas that are known as the broad and narrow line regions and in yellow is a radio jet. This diagram has been taken from Marin [2016][1].

3. Reverberation Mapping

The dusty torus will absorb bluer light from the accretion disc and re-emit redder light (or infra-red), like an echo. The dust is further away so the light from the accretion disc takes time to travel to the torus.

Since the red light mimics the blue light, you can measure the time it takes for the light to travel from the accretion disc to the dusty region (the sublimation radius). You can see this illustrated in Figure 3 as τ.

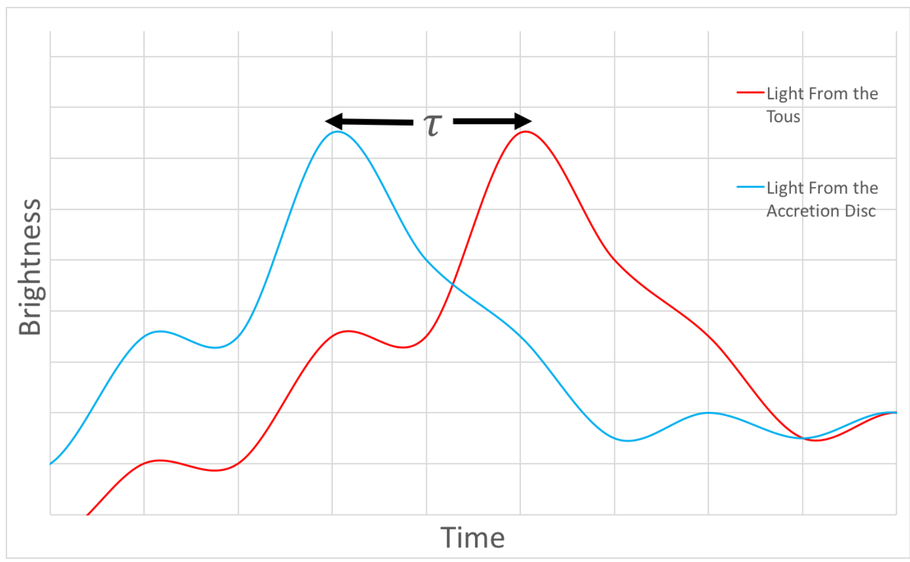

Figure 3: A visual aid showing how the light from the dusty torus would be delayed behind the light from the accretion disc.

This time is related to the distance that the light travelled, (from speed = distance/time). We know light travels at the speed of light (about 300,000,000 m/s) so can find out how far the light has travelled and therefore how big the Sublimation Radius is. This process is called Reverberation Mapping.

4. Future Work

The work that is carried out in the University of Southampton will find the sublimation radius for a sample Active Galactic Nuclei (such as the ones in Figures 1 and 4). From these AGN, we will investigate how the size of the sublimation radius is related to its brightness and what this can tell us about the galaxy and its history.

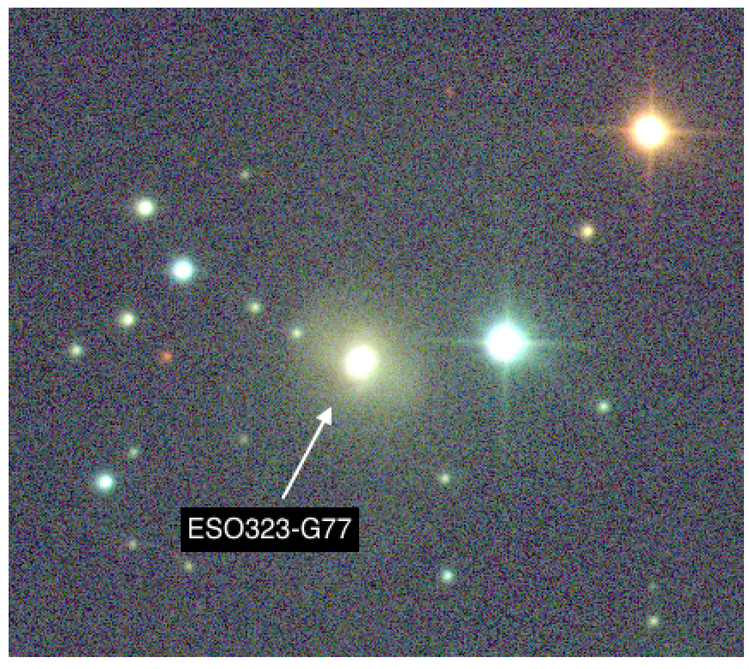

Figure 4: An image showing Active Galaxy ESO323 - G77 and some nearby stars.

References

1. F. Marin. Are there reliable methods to estimate the nuclear orientation of seyfert galaxies? *Monthly Notices of the Royal Astronomical Society*, 2016. doi: 10.1093/mnras/stw1131.

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