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When a massive star is in the late stages of evolution, it undergoes a gravitational collapse that results in an extremely violent supernova explosion and the formation of a black hole. A good amount of stars in the sky are in the so-called 'binary systems' where two stars orbit around one another. If the companion star survives the explosion, a star-black hole system is formed, called an X-ray binary.

In X-ray binaries, material coming from the star spirals into the black hole, forming an accretion disc, where very hot matter (about 10 million °C) heats up and produces X-ray radiation due to intense frictional forces. It is thought that, in addition, there is an even hotter plasma (about 10 billion °C) that sandwiches the disc around its inner regions, which we call the 'corona'. Of course, we have no information about what happens very close to the black hole, beyond the famous 'event horizon', where not even light can escape the tremendous drag of gravity produced by such a massive and dense object.

These objects can show abrupt changes in their brightness over timescales of seconds or even less. The small variations in the light that the instruments onboard X-ray satellites observe, carry encoded information about the mechanisms of the emission and the properties of the medium surrounding the black hole, which is of crucial importance as X-ray detectors do not have enough angular resolution to discern this geometry in their images.

What is interesting is that we observe both low energy 'soft' X-ray and high energy 'hard' X-ray photons, and we don't see these coming at the same time, but hard photons lag the soft ones by some fraction of a second. We assume that soft photons come from the accretion disc, whereas the hard ones come from the corona surrounding it. Now, lags can be explained by assuming that soft photons come from the disc, where perturbations in the outer rings of the disc propagate down to the inner radius, modulating the soft X-rays emission that we receive. In the inner regions, some of the soft photons collide with the hot electrons in the corona, gaining energy and becoming hard. Therefore the perturbations that reach the inner regions modulate the hard X-ray emission, producing the lags between the two bands that we observe.

A careful study of the light we receive from X-ray binaries using tools such as time lags, allows us to map these objects, constrain the mechanisms that govern their emission and ultimately understand black holes better.