

Astrowatch

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Massive black-hole pair is on fast-merger track

Earlier this year, astronomers discovered what appeared to be a pair of supermassive black holes (SMBHs) circling towards a collision, which would send out a burst of gravitational waves. A new study of the periodic signal from the quasar PG 1302-102 seems to confirm this interpretation by showing that it could naturally arise due to relativistic Doppler boosting.

Black-hole binaries are expected to be common in large elliptical galaxies, because they most likely form by the merger of spiral galaxies, each hosting a central SMBH. A way to find binary systems in quasars is to search for a period signal repeating over several years. This is quite challenging, owing to the erratic variability of these distant active galactic nuclei. Until recently, only one rather peculiar object, called OJ287, was clearly identified as a double black-hole system, with a smaller black hole plunging twice through the extended accretion disc of the primary black hole along its inclined, eccentric 12 year-long orbit.

In January, a team led by Matthew Graham, a computational astronomer at the California Institute of Technology, designed an algorithm to detect sinusoidal intensity variations from 247,000 quasars monitored by optical telescopes in Arizona and Australia. Of the 20 pairs of black-hole candidates discovered, they focused on the most compelling bright quasar – PG 1302-102. They showed that PG 1302-102 appeared to brighten by



Artist's conception of a pair of super-massive black holes, each surrounded by spiralling gas forming an accretion disc. (Image credit: P Marenfeld/NOAO/AURA/NSF.)

14 per cent every five years, suggesting the pair was less than a tenth of a light-year apart.

In a new study, also published in *Nature*, Daniel D'Orazio and his group at the Columbia University interpret the sinusoidal modulation as due to relativistic Doppler boosting. They find that the signal is consistent with a model where most of the optical emission comes from a smaller black hole orbiting a heavier one at nearly a tenth of the speed of light. At that speed – via the relativistic Doppler beaming effect – the smaller black hole would appear to slightly brighten as it approaches the Earth and fade as it moves away on its orbit. They note that hydrodynamical simulations do, indeed, suggest that the smaller black hole should be the brightest one.

According to this new interpretation,

the observed quasi-sinusoidal signal in the optical emission of the quasar should also be seen in the ultraviolet (UV). Analysing archival UV observations collected by NASA's Hubble and GALEX space telescopes, D'Orazio and colleagues found the same period with a 2–3 times higher amplitude. The stronger signal corresponds precisely to the model expectations, by taking into account the difference of spectral slope measured from the optical to the UV.

By estimating the combined and relative mass of the black holes in PG 1302-102, they narrow down the predicted time until the black holes coalesce to between 20,000 and 350,000 years from now, with a best estimate of 100,000 years – a very long time for humans but not in the life of stars and black holes. If confirmed by more observations in the years to come, this discovery and that of other binary black-hole candidates will improve the chances of witnessing a merger and the gravitational waves predicted, but not yet detected, by the theory of general relativity laid down by Einstein 100 years ago.

● Weblinks

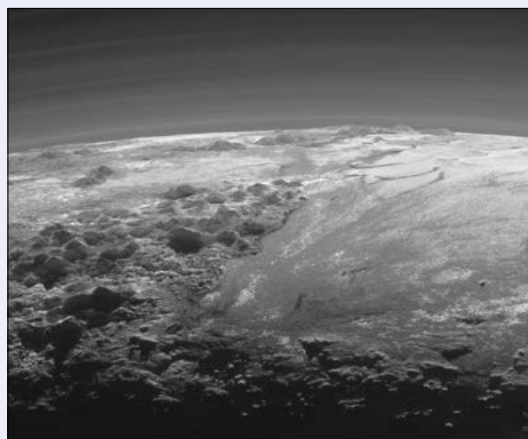
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Picture of the month

Just 15 minutes after its closest approach to Pluto on 14 July 2015, NASA's New Horizons spacecraft looked back towards the Sun and captured this amazing view of Pluto (Picture of the month, *CERN Courier* September 2015 p17). This near-sunset image offers a contrasting view between majestic mountains and frozen plains. The smooth expanse of the informally named Sputnik Planum (right) is flanked to the west (left) by rugged, icy mountains up to 3500 metres high, including the informally named Norgay Montes in the foreground and Hillary Montes on the skyline. The backlighting highlights more than a dozen layers of haze in Pluto's tenuous atmosphere, extending up to at least 100 km above the surface. Although the scene is only 380 km across, it displays a complex Earth-like view that scientists could not even dream to find on this remote dwarf planet. (Image credit: NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute.)

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