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THE X-RAY UNIVERSE

Ken Tapping, 7th February, 2017

There is a really interesting astronomical video circulating around the research community. It was obtained using the Chandra orbiting observatory, and shows a piece of sky as we would see it if we had X-ray eyes. It comprises a sequence of images accumulated over three months and is presented as a one-minute time-lapse movie.

It shows what looks like a piece of starry sky about a third the size of the Full Moon. Some of the "stars" shine steadily; others twinkle and flash. However, the twinkling of the stars we see in the night sky is due to turbulence in the atmosphere. The Chandra observatory lies out in space, well above the atmosphere, so those dots are truly flashing. Moreover, we are looking at the X-ray sky, and those dots are not stars.

Cosmic X-rays are interesting because they need a lot of energy to produce them. They require temperatures of millions of degrees, or particles accelerated to very high speeds. The outer atmosphere of the Sun – its corona - has million-degree temperatures and produces X-rays. However they are not strong by cosmic standards and we can only observe and map them because the Sun lies very close to us. To be visible at a distance of millions of light years requires energy of a different order entirely. Some of those dots could be distant galaxies containing lots of extremely bright, hot and massive blue stars. This could certainly explain those dots in the video that are shining steadily, but not those that are flashing on and off. Each flashing dot has to be a single body, and a small one, so producing that amount of energy in a small object requires rather extreme physics. The most likely explanation is that each one of those flashing dots is a black hole, the most efficient energy machine in the universe. These black holes probably lie in the cores of distant galaxies too far away for us to see.

A black hole is a highly-compressed lump of material that produces such an intense gravitational field that it shreds and sucks in anything passing too close and bends the fabric of space so severely that not even light can escape.

The energy released by material as it is sucked into a black hole is almost equivalent to the total conversion of that material into energy. For comparison a power station generating say 10 gigawatts (10 billion watts) is converting only about a tenth of a millionth of a kilogramme of its fuel into energy per second. The Sun manages 4 million tonnes per second and the black holes can convert entire stars to energy in very a short time.

The big question is where do the big black holes come from. Our galaxy and many others contain in their cores black holes millions of times the mass of the Sun. There are other black holes forming even now, as large stars collapse at the ends of their lives and then start to nibble away at anything passing too close. However, the massive black holes in the cores of galaxies are probably far too big to have achieved their size by snacking on their neighbours. It is possible they were formed when the universe began, just under fourteen billion years ago. This agrees with calculations that suggest galaxies need to form around black holes, which therefore had to exist before galaxy formation started, soon after the Big Bang.

The video shows well over 1000 black holes, suggesting there must be almost 700 thousand of them scattered over the whole sky. The total is almost certainly larger than that. With all these black holes, nibbling at their surroundings and sometimes merging, could it be that when our universe is old, all that will be left is a collection of black holes with only each other to nibble at?

Mars and Venus lie low in the Southwest after sunset. Venus is very bright. Mars, redder and much fainter, lies close to its left. Jupiter rises around 11pm. The Moon will be Full on the 10th.

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