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Astronomy
The Shape of Our Galaxy

Narrator
Galaxy experts have come from all over the world to an intimate workshop held at the Lorenz Centre, part of the Leiden Observatory, but even while they ponder today's favourite theoretical problems, data is being returned from some of the world's most advanced astronomical instruments probing the sky – not for optical light nor radio waves, but for heat. Infra-red observation has finally allowed astronomers to see the stars hidden behind the dust that populates the galaxy, and it's only been possible from space.

In the early nineties DIRBE, the diffuse background experiment on NASA's cosmic explorer satellite, opened new windows on our galaxy at ten wavelengths all across the infra-red spectrum. At the shortest infra-red wavelengths corresponding to the hottest sources, the radiation comes mainly from stars. They clearly outline the central bulge of the disc with lots of nearby bright stars filling the sky. But as we switch the camera to longer wavelengths the picture changes dramatically. The bright thin disc along the galactic plain is still there, but the central bulge of hot stars has almost gone. However, right across the sky is a fuzzy S-shaped band of light called zodiacal light. It comes from very close by interplanetary dust heated by the Sun in our own solar system. At even longer wavelengths this re-radiation from warm dust becomes even more prominent, but now we can see intense radiation from interstellar material concentrated along the galactic plain, and extending well beyond the nuclear bulge.

At the very longest wavelengths we're looking at cold interstellar dust. Wispy traces seem to fill our view of the entire sky with no identifiable features. All very pretty but what do these images tell us about the shape of the Milky Way? For instance, is there evidence for a bar-type feature in the centre of our galaxy as in this one? This might be an indication of how our Milky Way has evolved. In this picture all the data have been combined to remove the effect of dust, and show directly the distribution of the stars near the central bulge. The brightness has been colour-coded from white through red, down to green and blue for the faintest stars.

Michael Hauser, NASA Goddard Space Flight Center
The question now is can we see evidence in the shape of this light distribution for a bar-like feature in the Milky Way? When we look carefully now at this one micron map we see that indeed it is a little bit fatter looking and through the left of centre than to the right and it is indeed a bit brighter at each point to the left of centre than the corresponding point to the right of the image. So the DIRBE data giving us a multi-wavelength view of the central bulge of stars in the galaxy is supporting the idea that the Milky Way might indeed be a barred spiral galaxy.

Butler Burton, Leiden Observatory
Radio observations also show evidence for the existence of a bar in the central parts of our galaxy. If the orbits of the gas were circular then there would be a sharp transition as the line of sight crossed longitude zero between positive velocities and negative velocities. In fact, the observations both of neutro-hydrogen and of carbon monoxide show a blurring in this transition across longitude zero. This blurring is consistent with motions along elliptical orbits associated with a bar. Moving from the length scale of the bar we find a region which is a unique laboratory where phenomena occur which occur nowhere else in the galaxy, right down in the centre.

Narrator
In this impressive radio image of the central few hundred light years we can see dramatic evidence of streams of ionised gas moving rapidly along strong, arching magnetic fields. As we approach even closer we see wispy filamentary shapes in the central few light years, curving away from a bright radio source. And at the highest resolution astronomers have

identified Sagittarius A-star as the compact source at the very centre. To see if there are stars behind these whirling curtains of dust and plasma, astronomers must look in the infra-red wavelengths.

Reinhard Genzel, Max-Planck-Institut für Extraterrestrische Physik
Now when I first saw this picture I was really astounded by the great detail you could see obviously – single objects, single stars in there – and when looking at different colours, different wavelengths in the infra-red we can actually now see that these individual stars have individual colours, infra-temperatures. Now what could Sagittarius A-star the radio pointers actually be? Now the most plausible explanation probably is that it is, in fact, the very centre and a very massive central black hole. To really find out whether or not there in fact is a black hole in the galactic centre we need to measure closer in.