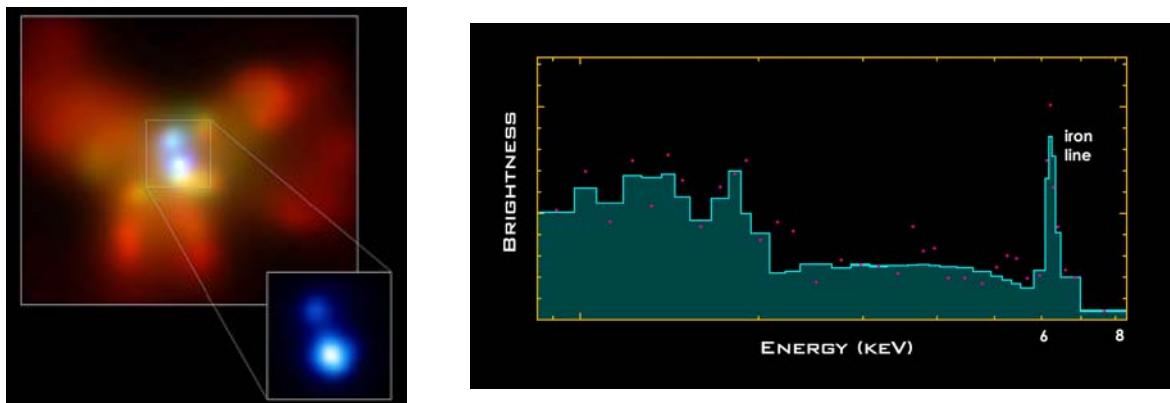


Imaging spectroscopy performed with the *Chandra* X-ray observatory led to the discovery of two active black holes in the nucleus of the luminous infrared galaxy NGC 6240. This is the first positive identification of an active binary black hole at the center of a galaxy. This discovery shows that massive black holes can grow through mergers in the centers of galaxies, and that these events may be detectable with future space-borne gravitational wave observatories.

The galaxy NGC 6240 is a prime example of a luminous infrared galaxy, a massive galaxy formed in the course of a recent collision and subsequent merger of two smaller galaxies. Because of the large amount of dust and gas in such galaxies, it is difficult to observe their innermost regions with optical telescopes. However, X-rays can penetrate the veil of gas and dust. Imaging spectroscopy performed with the *Chandra* X-ray observatory (Komossa et al. 2003) revealed that the nucleus of NGC 6240 contains not one, but two supermassive black holes, actively accreting material from their surroundings (Fig. 1). Both black holes reveal their presence by heavily absorbed but intrinsically luminous high-energy X-ray radiation and strong neutral fluorescent iron lines; the characteristic signatures of obscured active nuclei (Fig. 2). The detection of a binary black hole supports the idea that black holes at the centers of galaxies can grow by merging with other black holes. Detection of binary black holes and analysis of their properties is important for our understanding of galaxy formation and evolution (see Komossa 2003 for a review). Over the course of the next few hundred million years, the two black holes in NGC 6240 will drift toward one another and finally merge. Toward the end of this process a burst of gravitational waves will be produced of the kind which will be detectable with the planned space-based gravitational wave interferometer *LISA*. A search for further binary black holes in luminous infrared galaxies using *Chandra* is presently ongoing.



*Fig. 1:* *Chandra* X-ray energy image of NGC 6240 (red: low-energy X-rays, blue: high energy X-ray emission). The inset zooms onto the center of the galaxy and shows the hard X-ray emission from the environment of the two active black holes. *Fig. 2:* X-ray spectrum of the Southern nucleus of NGC 6240, showing strong iron line emission and hard absorbed, but intrinsically luminous, X-ray emission (the low-energy X-ray emission visible in the spectrum is due to extended starburst-related emission projected onto the nucleus). The spectrum of the Northern nucleus, intrinsically weaker, looks very similar thus revealing the presence of two active cores in NGC 6240.

#### References:

- Komossa S., Burwitz V., Hasinger G., Predehl P., Kaastra J., Ikebe Y., 2003, *ApJ* 582, L15
- Komossa S., 2003, in *The Astrophysics of Gravitational Wave Sources*, J. Centrella (ed.), AIP Conf. Proc. 686, 161