the stars at a distance r from the centre should be proportional to $1/r^{1/2}$, i.e., growing for progressively *smaller* radii, as for planets around the Sun.

Such Keplerian orbits should not arise if the mass is due to a spatially extended cluster of stellar-mass objects. With spatially distributed mass, the velocities would increase with distance or be less independent of distance, depending on the density profile of the stellar cluster. Thus, observations of stellar velocities became essential to the exploration of a possible supermassive black hole in the Galactic centre.

Focused observational programs led by Ghez and Genzel

Two observational teams, one led by Genzel at the Max Planck Institute for Extraterrestrial Physics (MPE) and the other by Ghez at the University of California, Los Angeles (UCLA), have been monitoring the motions of stars orbiting the Galactic centre for nearly three decades. Genzel's group used telescopes in Chile operated by the European Southern Observatory (ESO), while Ghez and her colleagues used the Keck Observatory in Hawaii.

Distinguishing individual stars in orbit in the very crowded region at the Galactic centre requires excellent spatial resolution. Obscuration by interstellar dust in the centre of the Milky Way inhibits observation at *optical* wavelengths, with less than about one photon per billion penetrating the dust along the line of sight to Earth. Therefore, the two teams carried out their observations in the *near-infrared* (the astronomical K-band), centred at λ =2.2 μm. At these longer wavelengths the mean-free path of photons is much larger, reducing the attenuation to only about a factor of 10, thus making the observations feasible.

The long measurement time needed to recover the signal and follow the stellar orbits around the Galactic centre rendered space-based observations impractical. Ground-based observations were necessary and the challenge became finding ways to compensate for the blurring that results from changes in Earth's atmosphere during the long measurement time. The technical solutions developed by both teams were key to their successes.

Detection of stellar motions in the Galactic centre

Turbulence in the Earth's atmosphere smears the photon trajectories at time-scales shorter than about one second. To compensate for this, both teams initially developed and used the technique of *speckle imaging* in the near-infrared. Very short exposures, just above a tenth of a second, were acquired with a very sensitive detector. The series of short exposures were spatially shifted to align the pattern of stars and added. The stack of shifted images provided a sharper and deeper image, ultimately limited by diffraction. For K-band observations at the 10-m telescope, the diffraction limit is about 0.05 arcseconds, corresponding to a spatial scale of 2.5 light days at the Galactic centre. Figure 4 (from Ghez et al. 1998) compares an individual image of the Galactic centre with those resolved from speckle imaging at the Keck telescope. The power of the technique to spatially resolve the stars in the central parsec region surrounding Sgr A* is clear.

With high angular resolution the resulting projected velocity vectors of a handful of stars could be determined after a survey over four years on the 3.5-m New Technology Telescope (NTT; Eckart & Genzel 1996, 1997); see figure 5. Genzel's team could also reach the diffraction limit on spatial resolution with the specially constructed SHARP camera. The velocity v of the stars, inferred from the shifts in their positions resolved through diffraction limited images, led to a successful measurement of the $v \propto r^{-1/2}$ behaviour expected for a single massive point source, as shown in figure 6.