Taking gravitational time dilation as well as the Lorentz factor into account, the resulting equation is $\left(1-\frac{2GM}{c^2r}\right)^{1/2}\left(1-\frac{v^2}{c^2}\right)^{-1/2}mc^2 = mc^2$, where v is the proper velocity, as measured by an observer at constant radius. This has the same solution as the analogous Newtonian expression. Thus, the two calculations happen to give the same result.

The period 1939-1964

In 1939, the American physicist Robert Oppenheimer, together with his student Hartland Snyder, managed to decipher the implications of Schwarzschild's metric (Oppenheimer & Snyder 1939). They studied the collapse of a spherical cloud of matter, and for the first time realized the full importance of the Schwarzschild radius, which they correctly identified with the presence of a horizon:

The star thus tends to close itself off from any communication with a distant observer; only its gravitational field persists.

A key assumption in the calculation of Oppenheimer and Snyder was spherical symmetry. Many physicists were concerned that without this assumption the endpoint of gravitational collapse could be something entirely different. After all, if the system was not spherically symmetric, how could in-falling matter focus itself to a single point and create a singularity? Could the collapse fail, with matter bouncing back out? Einstein expressed serious doubts about the existence of horizons at about the same time as the work of Oppenheimer and Snyder (Einstein 1939).

Such considerations led the Soviet physicists Evgeny Lifshitz and Isaak Khalatnikov to revisit the calculations, concluding that results like those of Oppenheimer and Snyder did not represent what actually happens in a real physical situation (Lifshitz & Khalatnikov 1963). In fact, they claimed that singularities could not occur under any realistic circumstances in general relativity:

The results presented allow one to draw the important conclusion that the singularity in time is not a necessary property of cosmological models of the general theory of relativity, and that the general case of an arbitrary distribution of matter and gravitational fields does not lead to the appearance of a singularity.

The American physicist John Wheeler is said to have had similar worries, speculating that quantum mechanics might hinder collapse toward a singularity, preventing the formation of this strange object called 'the singularity'. He imagined how the collapsing star would convert itself into gravitational radiation, rapidly evaporating away leaving nothing behind.

A remarkable observational discovery would follow this theoretical development.

The first observational hints for supermassive black holes

The discovery of quasi-stellar objects, abbreviated quasars or QSOs, generated a lot of interest. These were first detected as compact radio sources in all-sky surveys in the late 1950s without optical counterparts. Eventually, in the early 1960s, optical astronomers found visible blue objects associated with these sources, originally thought to be stars in our galaxy. A major breakthrough was achieved when the Dutch astronomer Maarten Schmidt (Schmidt 1963), following the accurate radio location obtained by Hazard, Mackey & Schimmins (1963), identified QSO 3C 273 as being an extragalactic source, with prominent spectral lines indicating a location outside of the Milky Way, at redshift z = 0.158. Both articles were published in the same issue of *Nature* in 1963. This result was very surprising, as the large distance to the point-like source (760 Mpc) implied a luminosity about one thousand times larger than that of our entire galaxy. The first discovery was soon followed by many others, at cosmological distances and with rapid random (non-periodic) time variation of emissions on the scale of days or even