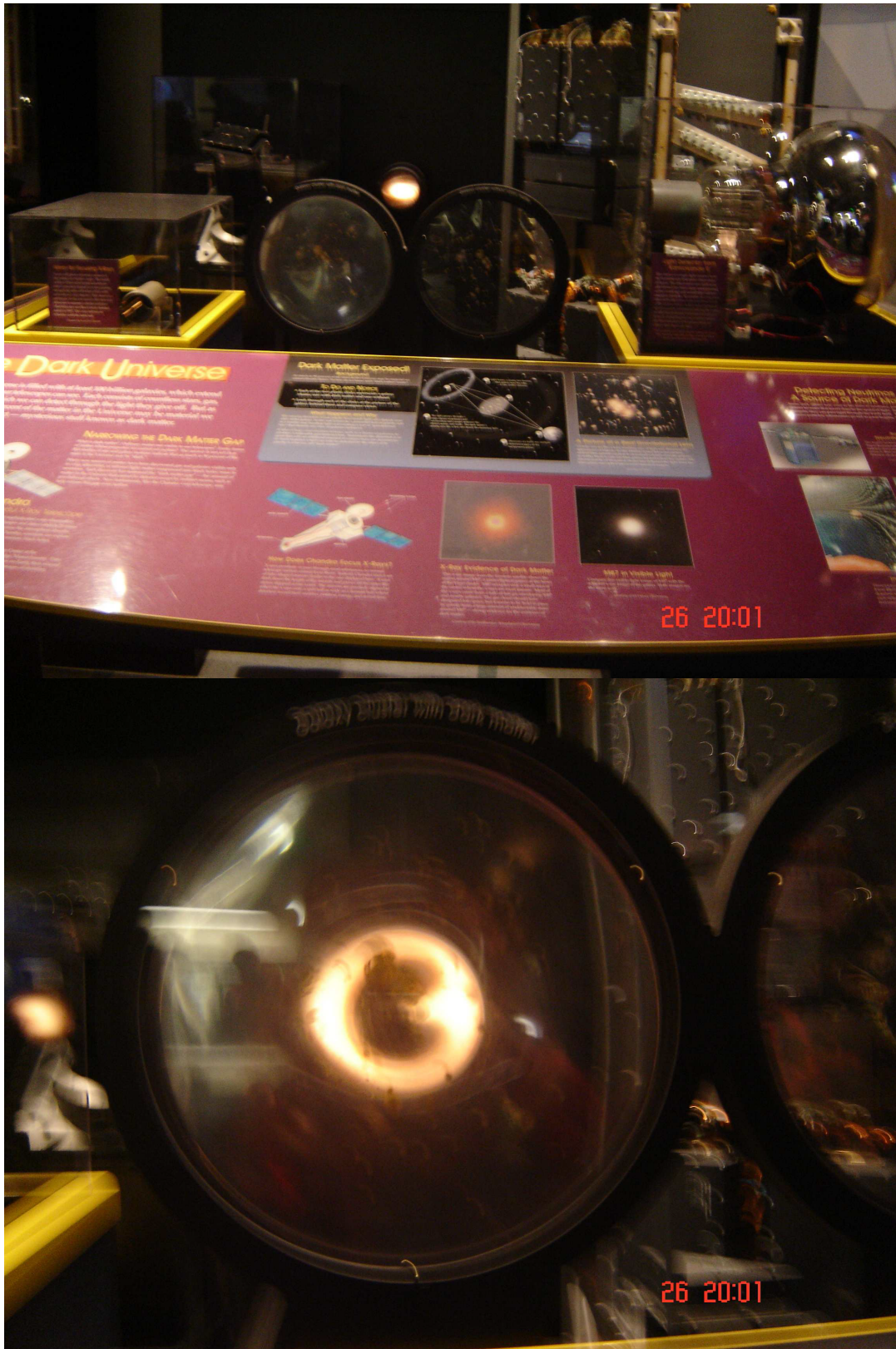


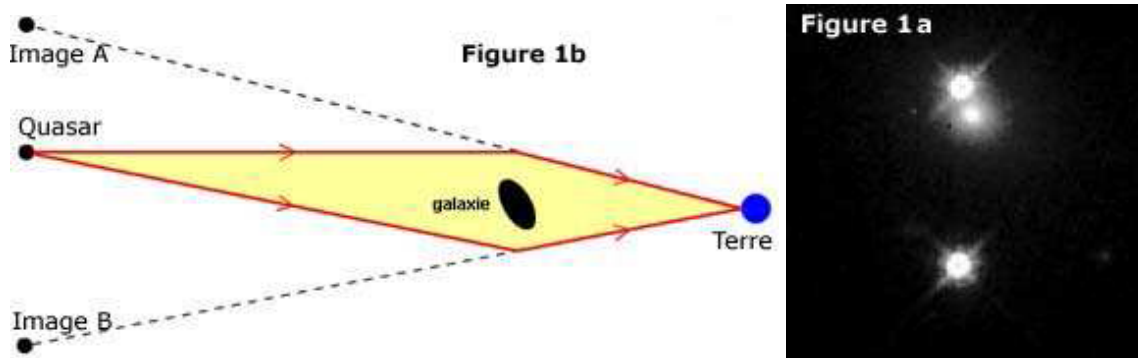
Gravitational lens simulator:

To buy a lens - <http://sciences.ulg.ac.be/2013/les-lentilles-gravitationnelles/>
a didactical experiment designed by J. and A. Surdej

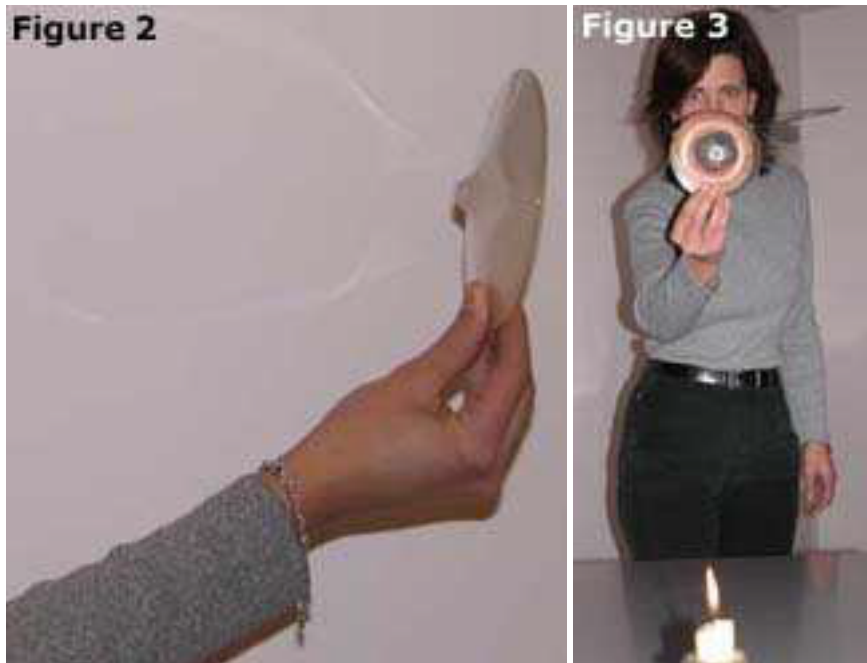


The above figure shows two gravitational lens simulators, designed and constructed by J. and A. Surdej, at the National Air and Space Science Museum (NASM, Washington) in the context of the 2000-2025 Cosmology exhibition.

In 1979, three British-American astronomers, Walsh, Carswell and Weymann discovered by chance in the sky the first example of a gravitational lens mirage, an illusion at the cosmic scale, which consists of two images of a bright background quasar (an active galactic nucleus), formed by a gravitational lens in the foreground (a galaxy mass; see Figures 1a and 1b).

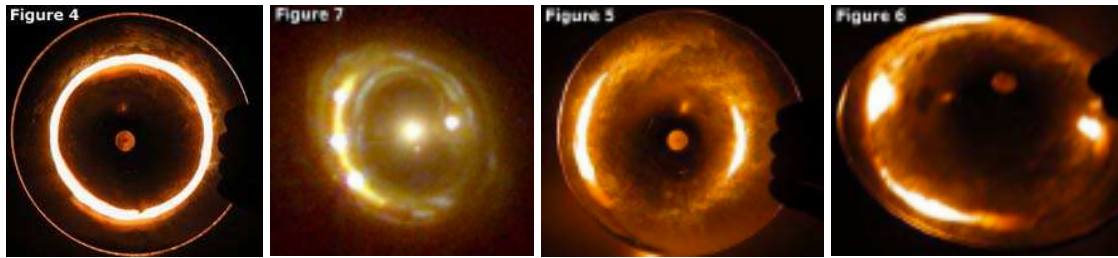


The formation of such cosmic mirages had been predicted within the general relativity developed in 1917. According to this theory, Einstein predicts that light rays emitted by a distant background source are deflected near a heavy and compact foreground massive object (the lens) located along the line of sight, like a star, a galaxy or even a cluster of galaxies. Therefore, a large concentration of mass may act as a kind of lens, called a gravitational lens. A simple educational experience makes it possible to simulate such effects. The Plexiglas lens shown in Figure 2 was produced in such a way that it bends light rays from a background source (cf. a light bulb flashlight, the flame of a candle...) alike a compact object (star, black hole...) having a mass approximately equivalent to $2/3$ that of our Earth. Thus, by placing this Plexiglas lens of 15 cm in diameter at arm's length, perfectly aligned with the background source (Figure 3), the observer can see a beautiful ring of light, commonly named the Einstein ring (see Figure 4).



When the alignment conditions are not perfect, the ring breaks into two lensed images (Figure 5). These are more or less alike the two lensed images of the distant quasar first discovered in 1979 (see Figure 1). Introducing an anisotropy in the mass distribution of the deflector, by tilting slightly the plexiglass lens, there results the formation of more complex gravitational mirages (4 lensed images and more, see Figure 6). Such a configuration of four lensed images superimposed over an Einstein

ring was observed in the cosmic bestiary of lensed quasars (see the gravitational mirage RXJ1131 recently discovered by astronomers from Liège, Figure 7).



More information on the description of this experience and gravitational lens mirages in general, are accessible via the page: <http://www.aeos.ulg.ac.be/GL/didactics.php>