New light on liquid telescopy

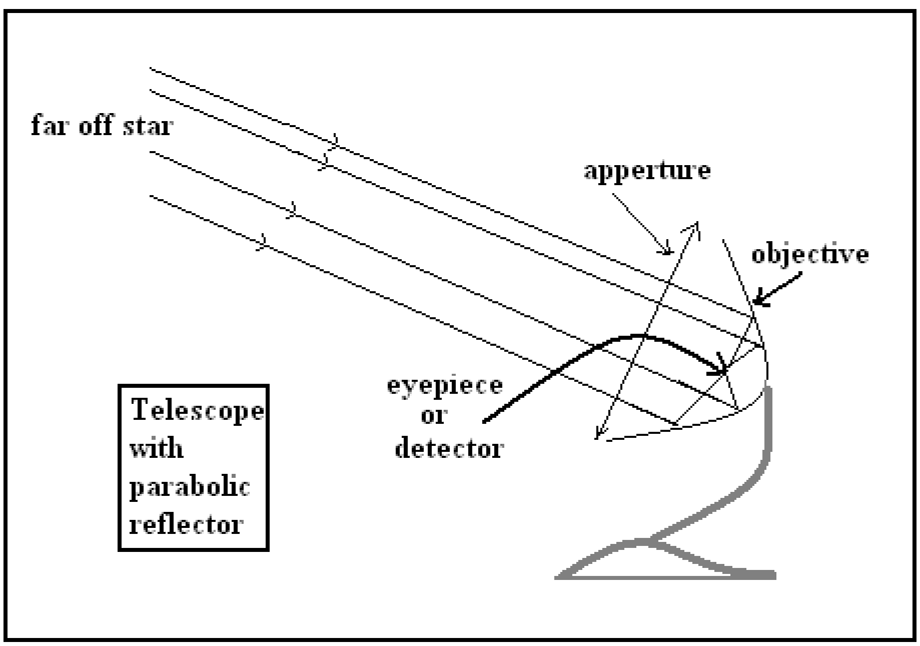
"Seeing the moon reflected in a pond" may resurrect in a useful way on the surface of the moon, says S.Ananthanaryanan.

A team of scientists, including Prof Ermano Borra from University Laval in Quebec, have moved towards creating a reflecting pool of liquid, on the surface of the moon, for high resolution cosmology.

The challenge

Astronomy has not looked back since Galileo discovered the telescope in the 17th century. These simple first telescopes were just a pair of lenses a few inches across and they provided a magnification up to 32x. Galileo was able to see sunspots and even discovered 3 of Jupiter's moons.

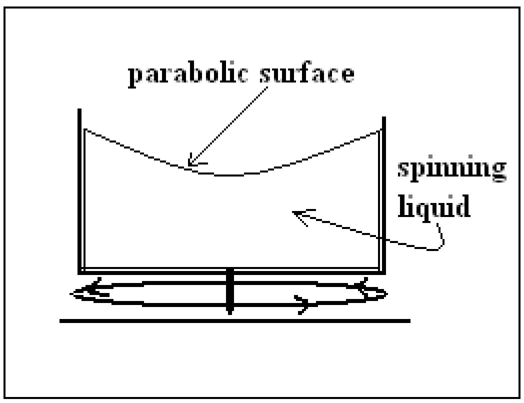
The challenge since then, in developing better telescopes, is to create larger lenses and mirrors, so that more light is captured and more detail is preserved when the image gets enlarged. Large optical telescopes built are with mirrors, rather than lenses and the largest have mirrors of diameters of about 10 metres.



Along with large apertures (diameter of lens or mirror), astronomers have also sought to place the telescopes in deserts and atop mountains, so as to cut the glare from cities and also to reduce the loss of clarity due to the atmosphere. Some telescopes are even placed in orbit around the earth, to eliminate glare and atmosphere altogether. But such telescopes have limitations of size and can be used for astronomy in the X Ray, or short wavelength radiation limit. This is because the resolution of a telescope increases when the light used is sharper, and smaller telescopes can still be effective. But such short wavelength light also gets scattered and for viewing the farthest and most ancient parts of the cosmos, astronomers' interest is in the long wave length, infra-red region. In this region, telescope apertures need to be large indeed.

Large reflectors

Large reflectors have been built using multiple sections, but this is not effective beyond a limit. Another approach was to use a liquid mirror, like the curved surface of spinning mercury. Such a curved surface can be made to be more curved or less curved by adjusting the speed of the spin and is also a very accurate, parabolic surface, which is just right for telescopes. The only trouble is that the formation of the mirror depends on gravity and such telescopes need to be always pointed straight up, or turned towards the zenith!



And again, for observing in the infra-red, the arrangement needs to be cooled to very low temperatures. The low temperature is required because a warm telescope gives off its own IR radiation, which would mask the faint signal coming from outer space! (It would be like using and ordinary telescope where the telescope frame was white hot). This and the fact that the atmosphere absorbs much of the IR radiation makes IR astronomy a difficult proposition on the earth

On the moon

Placing the reflector on the moon has many advantages. The temperature is naturally very low and there is no atmosphere to blur things. But finding a suitable liquid has been elusive. Even mercury freezes at -38º C. Other liquids must be reflective and also must not vaporize in the near vacuum on the moon's surface.

Ionic liquids

Prof Borra and colleagues report in the journal, ***Nature*** of 21st June that they have developed mirrors by depositing metallic silver on the surface of liquids that are stable at low pressures and could make suitable bases for mirrors 20 to 100 metres across, on the surface of the moon!

In normal materials, in the solid state, the atoms form crystals, where the charges are all balanced. In the liquid state, some of the charges separate, but most form pairs and exist as neutral molecules, or sets of atoms. The liquids then readily vaporise, as neutral bodies are able to escape. And then, in the gas phase, the material is all in molecular form, till it gets really hot, when the molecules break up and the gas is plasma. But what concerns us now is that liquids vaporize because they are mostly in the form of molecules.

Ionic liquids are the kind that exists as separate charged parts even in the liquid phase. Ready examples are salts, like sodium chloride, when they are melted. This liquid would not vaporize easily, as the sodium and chlorine atoms are charged and separate and subject to electric forces in addition to other forces.. But at 800º C, this liquid would be of no use to observe IR radiation.

Borra and colleagues have developed specific organic chemicals which show ionic behavior as liquids down to very low temperatures. And they have succeeded in coating the surface of such a liquid with a film of silver, which makes it reflective!

The technology could lead to practical IR telescopes with very larger apertures, on the surface of the moon and revolutionise the quality of observation of the universe in the infra red region of the spectrum.