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THE SEARCH FOR ALIEN LIFE

# Twinkle, twinkle, little planet

## An undervalued optical trick may help to find life in other solar systems


MOST astronomical telescopes employ reflection to focus starlight. A concave mirror creates an image from this light using a design pioneered in the 17th century, by Sir Isaac Newton. Those telescopes that do not employ reflection use refraction. They have a system of lenses, an idea first used to look at the stars by Galileo.

But there is a third way to focus light. A century and a half after Newton, and more than two after Galileo, a Frenchman called Augustin-Jean Fresnel worked out that you can do it using diffraction. A set of concentric rings, alternately transparent and opaque, will scatter and spread light waves in a manner that causes them to reinforce each other some distance away, and thus form an image. The rings are known as a zone plate. And Fresnel's countryman, Laurent Koechlin, of the Midi-Pyrénées observatory, thinks zone plates are the way to find out if there is life on other planets.

Seeing oxygen in another planet's atmosphere would be a giveaway of biological activity because the gas is so reactive that it needs to be continuously renewed. That would almost certainly mean something akin to photosynthesis was going on, for no known non-biological process can produce oxygen from common materials in sufficient quantity. Looking at such an atmosphere, though, is tricky. Stars are so much brighter than the planets which orbit them that their light overwhelms the small amount reflected from a planet's surface. And this is where Fresnel comes in.

Fresnel telescopes have not been developed in the past because the image formed by one that was large enough to rival a useful-sized reflecting telescope would be several kilometres from the zone plate. But Dr Koechlin does not worry about that, because his Fresnel telescope will be in space. Free of the confounding effects of the Earth's own atmosphere, it will be able to isolate images of alien planets, make spectra of the light from their air, and examine those spectra for the characteristic dark lines that are caused by part of the light being absorbed by particular gases — oxygen among them.

### PLATE TECTONICS

SPACE telescopes are nothing new, of course, and several more are in the works. But existing plans to photograph extrasolar planets in this way involve orbiting arrays of reflecting telescopes all pointing in exactly the same direction. An array is needed because a single mirror big enough to do the job of separating star from planet would be too large to launch. The problem is the word "exactly". It means just that. The formation would have to fly with a precision of a few billionths of a metre.

Using a zone plate instead of a mirror gets around this. Because the plate is flat, it can be made of plastic and folded up for launch. Size thus ceases to be an issue. And although a second satellite containing the "eyepiece" (a special lens that also uses Fresnel optics, and a camera to record the image) must fly at the focus, the accuracy required is only hundredths of a metre, not billionths. That, Dr Koechlin reckons, gives Fresnel optics a big advantage over Newtonian ones.

To test the idea, he and an international consortium of his colleagues have built a ground-based prototype. This is a piece of copper foil 20cm square that has 696 rings, a portion of which is reproduced above. Because it is this small, its focal length is only 18 metres. In order that the foil does not fall apart, each transparent ring is actually a series of curved slots in the copper rather than a continuous gap. This, though, does not affect the system's optical properties and it can, indeed, see small, faint objects that are near large, bright ones.

When Dr Koechlin and his team pointed it at Mars they could distinguish that planet's two tiny moons — a task which would require a Newtonian telescope with a mirror at least 30cm across. And when they aimed at Sirius they could see the dim white-dwarf which orbits what is the brightest star in the night sky. Extrapolating from these results, they think that an orbiting zone plate measuring somewhere between 15 metres and 40 metres across will be enough to distinguish the spectrum of an Earthlike planet at a distance of 30 light-years. With that, they should be able to find out if mankind really does have any next-door neighbours, and Fresnel will have come into his own at last.