The Nature of Things

Making eyes at the universe

Andrew Derrington explains why hats are helping astronomers at the Roque observatory

The street lamps in the village of Barlovento on the Canary island of La Palma wear hats to direct their light downwards. This is just one, but perhaps the quaintest, example of the symbiosis that exists between the people of La Palma and the astrophysical observatory at the Roque de los Muchachos, 7,000ft above sea level on the island's bare and snowy summit.

Javier Méndez, public relations officer of the Isaac Newton Group of Telescopes (ING) at the observatory, explains the hats. Light pollution is one of the worst enemies of the astronomer, he says. Light from ground level contaminates the light from the stars. Consequently, the Canary Islands government requires all street lights in the northern part of La Palma to have hats to minimise the amount of light they direct upwards into the night sky.

Méndez says that the 70,000 islanders are pleased to co-operate with the observatory, which is one of the best in the world, because of the international renown that it brings the island.

At the Roque, as it is affectionately known, there are three telescopes run by the ING, a joint venture serving British, Spanish, Dutch and Irish scientists. The main element of each telescope is a large, concave mirror that concentrates light on a system of smaller mirrors and lenses. These can be configured either to form a high resolution image of a small part of the sky or to direct the light from a particular object on to measuring equipment.

The William Herschel telescope, the largest of the three, has a mirror 4.2 metres in diameter weighing more than 16 tonnes. It can resolve objects 1 arcsecond apart – about 60 times better than the naked eye – which is sufficient to read the Financial Times from a range of 100 metres.

The resolution would be better if the telescope were in outer space. Even in the calm, clear conditions prevailing at the Roque, atmospheric turbulence distorts the image. "It's like looking down into a swimming pool and trying to read a newspaper lying on the bottom," says Chris Benn, the astronomer who manages the telescope.

The Hubble space telescope, orbiting above the atmosphere, has resolution 10 times better than the William Herschel, with a mirror half the size. The ING cannot launch its telescope into space, but it has a couple of tricks for improving matters.

It has already begun a "half arc-second programme" which will double resolution by removing all sources of heat from the telescope building where convection currents cause air turbulence.

In the longer term it will use adaptive optics to bring resolution up to about 0.1 arcsec, Benn says. The system will work by monitoring the image of a bright star to measure the distortion induced by atmospheric turbulence and continuously changing the shape of the mirror so that it cancels the atmospheric distortions.

> The telescope could detect the light from a single candle on the surface of the moon

Research projects on the William Herschel telescope span the three big areas of astronomy: the origin and history of the universe, the behaviour of matter under extreme conditions not attainable on Earth, and the search for extra-terrestrial life.

About 80 per cent of this work involves measuring the intensity and wavelength of the light from different objects, rather than making pictures of them. Big telescopes can make these measurements more precisely because they catch more light. Benn likens the William Herschel to a bucket for light. It catches about 1m times more than the human eye, and four times more than the Hubble telescope. It could detect the light from a single candle on the surface of the moon, Benn says.

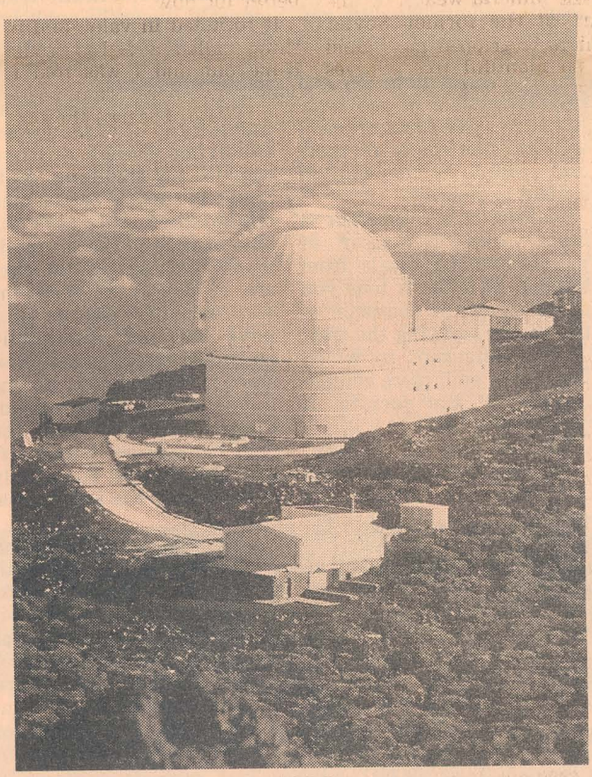
The colour of light, determined by the spectrum of wavelengths, carries a huge amount of information. The colour of a newspaper indicates whether it is the FT or a lesser broadsheet. The spectrum of light from a star can show which chemical elements it contains, its speed of motion and its distance.

Each chemical element emits a characteristic set of wavelengths. The gas helium was first discovered on the sun, where it is produced continuously by nuclear fusion. If a star is moving away from us, the distinctive signatures for each element are shifted towards red. Approaching motion causes a shift towards blue.

Benn uses the William Herschel telescope to study quasars, the faint, star-like objects that were first identified in the 1960s and are now known to be the exploding nuclei of distant galaxies.

The red shift in their spectra tells him that they are moving away from us at tens of thousands of kilometres per second. The high velocity of quasars is caused by the expansion of the universe, and is the best clue to their distance. The quasars are thousands of millions of light years away: the light Benn is measuring was emitted when the universe was young.

■ *The author is professor of psychology at the University of Nottingham.*



Herschel telescope: a bucket of light Royal Greenwich Observatory