TUNABLE FILTERS

From raw telescope data to calibrated astronomical information

By HÉCTOR CASTAÑEDA and ANGEL BONGIOVANNI,
IAC researchers and Winter School tutors

A wide range of astrophysical processes produce optical emission in the form of well defined lines. These emission lines can be observed in a wide variety of objects, from small nebulae known as planetary nebulae to the nuclei of galaxies that harbour black holes in their interiors. The wide range of objects to be studied and their importance in relation to the study of the evolution of the Universe makes the study of emission lines in astronomical objects a fundamental activity for astronomers.

The astronomer´s ideal would be to have access to an infinite set of different filters, each designed for the study of one line in particlular. Not only that, but it is also necessary to take into account that the object moves in space, causing the line to be displaced in the spectrum (for example, when the object moves away from the Earth, the emission lines are displaced towards the red end of the spectrum, which means that the object we are studying becomes redder). This implies the need to add yet more filters to our collection.

The practical solution to this problem is the construction of tunable filters. By this concept we mean filters that can arbitrarily select the wavelengths in which we wish to observe, together with how much of the spectrum we wish to measure at any given time (known technically as <<bandwidth>>). These filters not only offer greater flexibility in the choice of wavelength but are also nowadays simple to operate, with the possibility of mounting them on 8 to 10 metre-class telescopes.

OSIRIS (*Optical System for Imaging and low-Resolution Integrated Spectroscopy*), the Spanish Day One instrument for the GTC (Gran Telescopio CANARIAS), will have the option of using tunable filters, each optimized for a part of the optical spectrum to suit the observation being carried out at the time.

A large part of the time used by the instrument will be dedicated to observing well defined emission line objects. As a preparatory activity, part of the classroom time of the Winter School will be dedicated to teaching students the basic tools that will enable raw data taken at the telescope with tunable filters to be converted into calibrated astronomical data that form the basis for the scientific studies being pursued by researchers.