Photon spectrometers based on diffraction grating

Roger Hutton, Lund University, Sweden (physics) and Beijing Normal University, China (Astronomy)

We begin with how a normal DVD can be used as a very basic spectrometer. However, a DVD is good enough too see the Fraunhofer absorptions lines in the Sun (at least the Na D lines, yellow). What are the differences and similarities compared to the classic Czerny-Turner mounting of a plan diffraction grating.

We will discuss why the electromagnetic spectrum is divided into different regions, i.e. infra-red, visible, ultraviolet, vacuum ultraviolet, soft x ray and x ray. Grating based spectrometers work in all regions except for x rays. The Czerny-Turner mounting requires three reflections and this looses in efficiency for short wavelengths, basically below 200 nm.

The solution to this lack of efficiency is solved by using a concave grating and we discuss the imaging properties of these optical components. Basically, many of the properties of diffraction grating spectrometers are governed by the grating equation:

$m\lambda/d = \sin\alpha + \sin\beta$.

There are two spectrometer geometries based on concave diffraction gratings, so called normal and grazing incidence. A major break through for the grazing incidence geometry came about by asking why does the lines spacing need to be constant. This led to the idea of flat-field and aberration corrected spectrometers.

We finish with a look at echelle-based spectrometers when the groove spacing is quite large, leading to the m in ml/d being very high. Most observatories use echelle-based spectrometers when observing the visible region of the electromagnetic spectrum.

I will look for relevant references and publications