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A Grazing Incidence Vacuum Ultraviolet Monochromator with Fixed Exit Slit for Use with Distant Sources

C. Kunz, R. Haensel, and B. Sonntag
Deutsches Elektronen-Synchrotron DESY, Hamburg, and
II. Institut für Experimentalphysik der Universität Hamburg

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C. Kunz, R. Haensel, and B. Sonntag

Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

and

Physikalisches Staatsinstitut, II. Institut für Experimentalphysik der Universität Hamburg, Hamburg, Germany

The only types of spectrograph mountings, which have been of practical importance in vacuum ultraviolet spectroscopy below ∿ 300 Å wavelength are those with grazing incidence, especially the Rowland mounting. Two major disadvantages of these mountings are the overlapping of higher orders and the continuous change of the exit (or entrance) path of light, when the instrument is operated as a monochromator. Severe limitations are caused by the change of the light path, when immovable light sources (for example, electron synchrotrons[1]) are used at the entrance arm and heavy components (for example reflectometers and UHV systems) are attached to the exit arm.

We have developed a spectrograph mounting, which promises to overcome both disadvantages. This spectrograph was especially designed to take advantage of DESY synchrotron radiation, which is nearly parallel since it is used about 40 m from the source, but it will also be capable of operating with other electron synchrotrons and other sources of nearly parallel light such as cosmic objects.

Principle of operation. Figure 1 illustrates the principle of operation of the proposed monochromator. We will first consider a fixed wavelength λ in Fig. 1a). Parallel light is incident from the left on the mirror M with a grazing angle φ_M and is reflected to the center of the grating G. In one mode of operation the grazing angle φ_G of the light incident on the grating is equal to φ_M so that the $\lambda = 0$ direction is parallel to the primary direction. Only light emerging from the grating in a definite fixed direction given by the angle γ (and thus of a certain wavelength λ) is accepted by the angle defining system. This system consists of a spherical or paraboloidal focussing mirror F and the fixed exit slit S of the monochromator. The grazing angle φ_F to the focussing mirror is fixed.

Change of the wavelength is illustrated in Fig. 1b) and c). The mirror M is moving along the linear path AB and at the same time turning about an axis a_M in such a way that it always illuminates the center of the grating. Simultaneously the grating G is turning about the axis a_G so that it is always parallel to the mirror M. The angles $\varphi_M = \varphi_G$ are continuously increasing and at the same time the wavelength λ passing through the exit slit is increasing.

The main properties of this mounting are:

1. The exit direction and exit slit are fixed.
2. The angle γ can be chosen twice the blaze angle of the grating so that the grating will operate for all wavelengths in the blaze maximum.
3. Use is made of the fact that there is a minimum wavelength reflected by a surface depending on the angle of incidence to the surface. Since the grazing angle of incidence to the mirror M and the grating G are increasing with increasing wavelength, the parameters of the monochromator can be chosen to suppress higher order reflections from the grating over a wide range.
4. The energy resolution for a fixed angular acceptance of the system is nearly proportional to the photon energy meaning constant resolving power. In this respect it is more favorable in solid state work than a Rowland mounting where the energy separation is proportional to photon energy squared. A resolution of 0.1 eV or better should be achievable at 100 eV photon energy.

Another version of the monochromator results when the mirror M in Fig. 1 is replaced by a second grating identical to the first. This should give an improvement in resolution and reduce straylight background.

A spectrograph which can be operated with either a mirror or a grating in the leading position is being built for use at the DESY electron accelerator. It is planned for operation at wavelengths down to about 40 Å.

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References

1 R. Haensel and C. Kunz, Z. Angew. Phys. 23, 276 (1967).

Figure Captions

Fig. 1 Monochromator mounting in successive stages of operation (wavelength increasing from a) to c)). Parallel light is incident from the left and reflected by the mirror M to the center of the grating G. M is travelling along the path AB and turning about the axis a_M while G is turning about its axis a_G. Radiation of a definite wavelength is focussed by the concave mirror F into the fixed exit slit S. The other symbols are explained in the text.

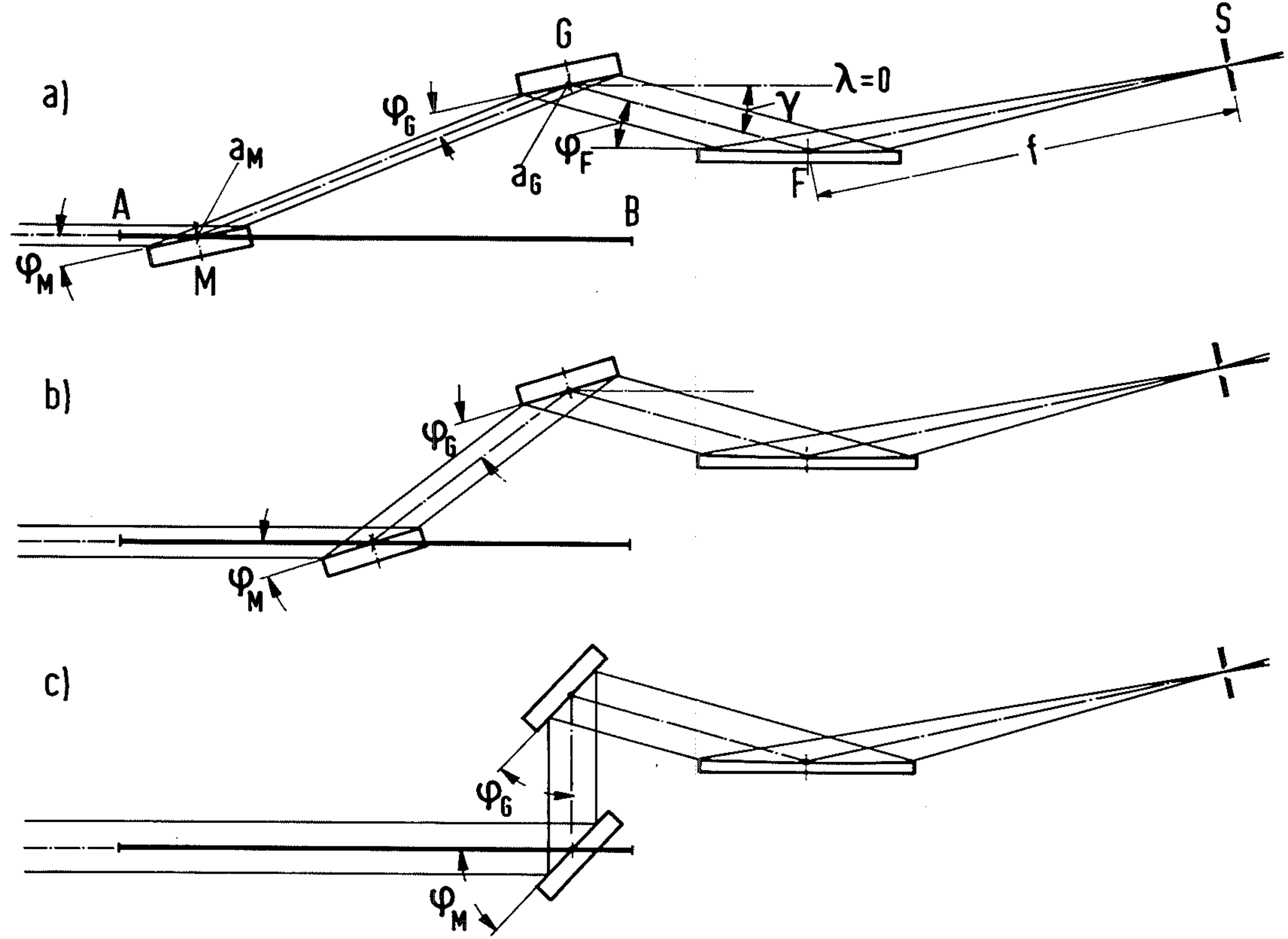

Figure 1