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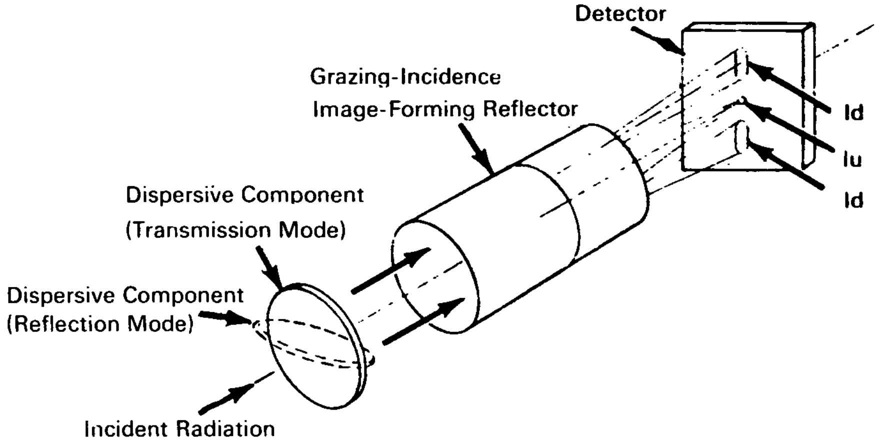
NASA TECH BRIEF

Imaging Slitless Spectrometer for X-ray Astronomy



The problem:

To obtain simultaneous spatial and spectral data from celestial soft x-ray sources. Spectrographic instrumentation was needed, which would be well-suited for work with electromagnetic radiation in the wavelength ranges where optical systems with standard refracting or reflecting components do not function. For example, in the 1 to 100 angstrom range, slitless refracting spectrometers cannot be used because of very high absorption in their lenses, and because the index of refraction for all materials at these wavelengths is very nearly equal to 1.000. Standard reflecting optics also cannot be used since the reflection coefficients at the reflecting angles typical of such systems are very small.

The solution:

An imaging slitless spectrometer, designed for use in x-ray astronomy, which is a combination of an x-ray transmission (or reflection) grating and an image-forming x-ray telescope. It is capable of obtaining simultaneous spatial and spectral information about celestial x-ray sources, at relatively high resolution (1 minute of arc). The instrument could be adapted for use at any wavelength range in the soft x-ray spectrum, but is especially suited for the 2Å to 15Å range.

The instrument has a large collecting-area to detector-area ratio, furnishing high-quality spectral data on weak x-ray sources. It is capable of examining a source at high angular resolution at all wavelengths in a given range simultaneously. Further, it can be used in a spectral region where the application of a Bragg crystal spectrometer is difficult, because of the size of available crystal lattice constants. A Bragg spectrometer also cannot easily measure continuous spectra.

How it's done:

The instrument incorporates a dispersive component, a grazing-incidence image-forming reflector, and a detector. The dispersive component can be a diffracting crystal or an array of crystals, or a grating or array of gratings constructed for optimal optical

(continued overleaf)

effect in the desired spectral range. The dispersive component can be used in the transmission or reflection mode of operation as indicated in the schematic. The grazing-incidence image-forming reflector is a metallic system composed of a paraboloid and a confocal hyperboloid reflector. The detector can be a photographic plate with x-ray emulsion, or other suitable detecting or recording sensors such as fluorescent screens, scintillation crystals, or counters.

Part of the incident radiation passes through the dispersive component undeviated and is imaged at Iu on the detector surface by the grazing-incidence reflector. Another part of the radiation is deviated by the dispersive component to areas on the detector indicated by Id. The deviation is a function of the wavelength; thus, the intensity distribution of the deviated rays on the focal surface represents a spectrum of the source.

Notes:

1. Possible applications of the spectrometer include the determination of the temperatures, densities, and compositions of hot plasmas (above 10^6 °K) from the spectral distribution of the x-rays emitted. The instrument may also be used for x-ray microanalysis of surfaces and small samples.
2. Documentation is available from:
   Clearinghouse for Federal Scientific
   and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: B68-10546

Patent status:

No patent action is contemplated by NASA.

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