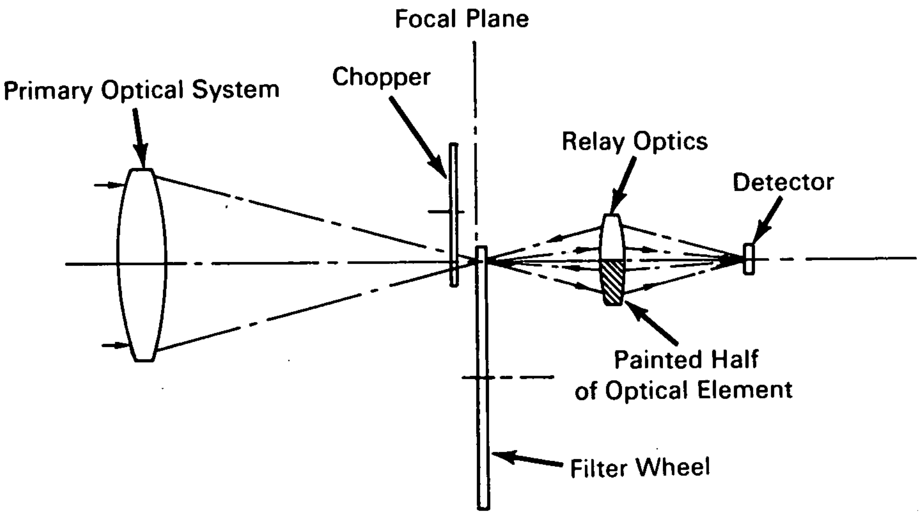
July 1968
Brief 68-10245

# NASA TECH BRIEF



## Improved Relay Optical Element for Spectroradiometer Using Cryogenically Cooled Detector




**The problem:**

In a spectroradiometer using a circular, variable filter wheel, a relay optical element is generally necessary to reimage the radiation passing through the filter wheel onto a cryogenically cooled detector. The radiation reaching the detector consists of the chopped radiation passing through the filter wheel, the radiation emitted by the detector itself and reflected by the filter wheel back to the detector, and the radiation emitted by the filter wheel and the relay element. However, the reflectivity (and consequently the emissivity) of the back of the filter wheel is not constant in the circular direction, but varies in an irregular manner as the spectral passband changes. The radiation emitted by a cryogenically cooled detector itself and reflected by the filter wheel back to the detector is a very small portion of the total radiation being viewed; and the variation due to changing reflectivity of the filter wheel is small. However, the radiation emitted by the filter wheel (which is at ambient temperature) and reaching the detector is wide band. Since the radiation to be measured passes through the narrow spectral bandpass of the filter wheel, the electronic signal generated by the changing emissivity of the filter wheel is considerably higher than the electronic signal generated by the chopped signal passing through the filter wheel. The signal generated from the back of the filter wheel, which is added to the chopped radiation signal, could in certain cases be eliminated with standard electronic demodulation techniques. These would require making the chopping frequency considerably higher than the highest frequency content of the radiation from the back of the filter wheel. However, if the filter wheel

(continued overleaf)

were to be rotated more than a few cycles per second, the chopping frequency would be higher than can be practically achieved. Even if the necessary chopping frequency could be achieved, the signal level from the back of the chopper is sometimes high enough (compared to the chopped signal) to saturate the first stage of the detector preamplifier before effective electronic filtering can be applied.

**The solution:**

The effect of the reflected radiation from the back of the filter wheel can be eliminated optically by coating half of one element in the relay optical system with a very high emissivity paint. This arrangement causes the detector to view a constant level of radiation, regardless of how the reflectivity of the back of the filter wheel changes. As the wheel rotates, its reflectivity changes, and the amount of radiation emitted by the blackened half of the relay optical element, reflected off the back of the filter wheel, and focused onto the detector changes in direct proportion. Since in all spectral bands (except the very narrow passband of the wheel) the reflectivity and emissivity must add to unity, the change in radiation reflected by the filter wheel is balanced by the change in radiation emitted by the wheel itself. Therefore, if the filter wheel and the relay optical system are at the same ambient temperature, the radiation reaching the detector appears as though it were emitted by a constant source at ambient temperature. Since this radiation is constant with time, it can easily be separated electronically from the chopped radiation passing through the filter wheel merely by using an ac-coupled preamplifier.

**Note:**

This information is complete is itself. It is presented here for its potential value in the application or adaptation to the reader's own needs.

**Patent status:**

No patent action is contemplated by NASA.

Source: A. R. Kraemer
of Lockheed Missiles and Space Company
under contract to
Manned Spacecraft Center
(MSC-11688)