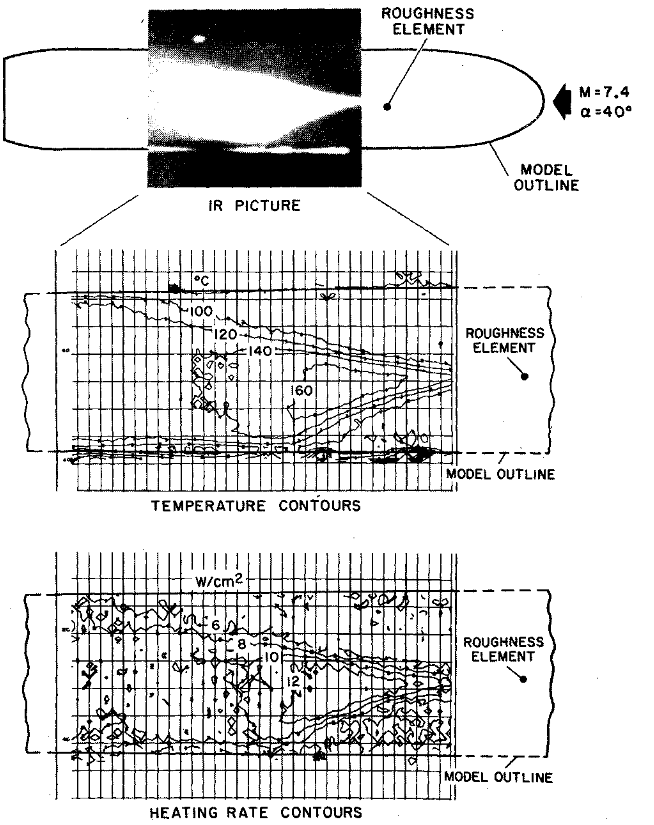

Fig. 4 Measurement of temperature and heating-rate distributions through a turbulent wedge by means of an infrared camera.

have easily escaped notice otherwise, since the model also had intentional roughness. Superposed on the outline of the model is a photograph of the viewing screen of the camera. Lighter regions have higher temperatures, and the turbulent wedge stands out clearly. The hot regions on the sides of the model are produced by pieces of tape. The lower two parts of the figure show computer-generated temperature and heat-transfer plots from this run. The turbulent wedge is evident in both of these plots.

In conclusion, the use of an infrared-imaging comera to obtain heating-rate distributions on complex aerodynamic shapes offers the opportunity to decrease data reduction time substantially with an accuracy in the data that is acceptable for most situations. Compared with thermocouples, the infrared camera offers the advantage that detailed heating-rate distributions can be more readily obtained. Compared with phase-change paint,[3] the problems of data handling for the camera are more amenable to automation since the camera output is directly in the form of voltage; thus, there are no photographic records to read. Furthermore, the camera can give the time history of heating rate, whereas phase-change paint can give only the time-averaged rate up to the time of phase change. This can be important if, as sometimes happens, transition on the model moves substantially during the test.

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Observation of Ultraviolet Radiation from a Rocket Exhaust Plume at High Altitudes

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DURING the past two years, several attempts have been made to observe vacuum ultraviolet radiation emitted from manmade events in space. The Orbiting Astronomical Observatory (OAO) –2, which was designed to observe the vacuum ultraviolet radiation from celestial bodies, was considered to be a system that could be used for these observations.[1]

The OAO has an exceptionally stable platform and a very high pointing accuracy. In addition, the spectral photometers provide a wavelength coverage from 1000Å to 4000Å. The first attempt to obtain vacuum ultraviolet radiation from manmade events occurred during the flight of Apollo 13. The Smithsonian Astrophysical Observatory Celescope experiment instruments at one end of the OAO were employed to obtain uvicon photographs of the liquid oxygen dumped from the Saturn SIVB stage after translunar injection. We were interested in the effects of solar radiation on the LOX dump that was continuously illuminated by the sun. This experiment did not produce a positive indication that the observation was successful.

The next event that was considered involved the release of barium at very high altitudes. It was felt that information concerning the vacuum ultraviolet emission from the barium cloud would aid considerably in the understanding of the various radiation processes involved, including the effects of solar radiation and interaction with the earth's atmosphere at high altitudes. However, a careful analysis indicated that the small field of view of the Wisconsin Experiment Package on OAO-2, 10 min of arc, was too restrictive considering the uncertainties of the exact time of release of the barium cloud and the exact altitude and position of the cloud. This study led us to consider events that involved less positional error. After careful consideration, it was conjectured that the best observational conditions involved the exhaust plume of a rocket system already in orbit or a system going into orbit.

Recently, an observation of the exhaust plume of a rocket engine was made. Because of the nature of the OAO trajectory and the missile trajectory of the target vehicle, we were able to view the exhaust plume only for about 4 sec. During this time measurements were obtained in the 2980Å, 2380Å, 1920Å, and 1500Å spectral regions. The characteristics of these photometers are given in Table 1 together with the peak irradiance values. The actual data in digital counts are shown in Fig. 1. The digital

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Index categories: Combustion in Heterogeneous Media; Solid and Hybrid Rocket Engines; Rarefied Flows.

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Table 1 Photometer characteristics

Photometer	Filter, Å	Bandwidth, Å	Peak Irradiance, w/cm² Å
1	2980	400	2.5×10^{-19}
2	2380	380	2.7×10^{-19}
3	1920	260	2.6×10^{-19}
4	1500	300	$<4.8 \times 10^{-18}$

count before and after the radiation from the exhaust plume represent the system noise level for a nonsunlit space background. It is clear from the illustration that any target radiation received by the 1500Å photometer was below the system noise level. At the present time we have been unable to attribute the radiation, based on the observed spectral distribution, to any particular molecular system.

A careful analysis of the OAO field of view, trajectory of the rocket engine, and viewing geometry of the experiment provides an indication that the radiation detected by photometers 1, 2, and 3 in Table 1 may originate in the region of mixing between gases from the exhaust plume and atmospheric gases. The rocket engine was at an altitude such that continuum fluid dynamics could not be employed to describe the far field of the plume. At the present time, the plume far field is being analyzed using the techniques of rarefied gas dynamics.

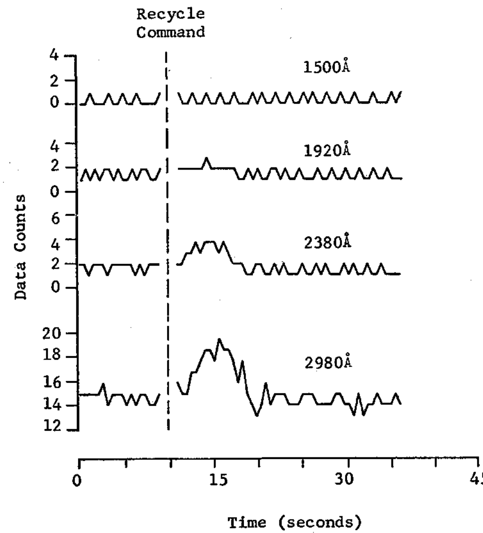

Fig. 1 Digital data received from OAO-2 Wisconsin photometers.

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