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"Photography of the Infrared Airglow from the CV 990 Airborne Laboratory during the Space Shuttle Simulation"

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Approval of this grant was received while the Principal and Co-Investigators were on sabbatical at Haleakala Observatory, Maui, Hawaii performing an extended series of photographic observation of the OH airglow.

During the fall of 1974 numerous items were ordered, the flight instruments designed, and preliminary experiments performed with a two-stage electrostatically focused image intensifier tube (I.T.). Earlier we had found that a 3-stage I.T. would permit the airglow to be recorded with a 1/15 sec exposure using a broad band filter (700-900 nm). However, this tube has very large pin-cushion distortion and a non-uniform photocathode. With the two stage I.T. we hoped to obtain photos of the individual bands, through 100Å interference filters, in exposures of about one second. Here we had to compromise and use the wide-band filter to get a 1-sec exposure which we deemed necessary to minimize the effects of smearing due to aircraft roll. Earlier experiments with a selected one-stage I.T. showed it did not significantly reduce the 5-minute exposure time required by regular high speed infrared film and a fast camera, and it was therefore not satisfactory.

Several tests of various transfer lens systems, to image the I.T. output screen onto the recording camera film, revealed that a) no closeup lens system, or single lens with extension tubes, will operate well at 1:1 imaging; b) Two 35-mm camera lenses face-to-face make a good transfer lens but the field of view is restricted to about 15-mm; c) oscilloscope recording lenses designed for 1:1 imaging offer the best results for this work.

Our two filter photoelectric photometer with manual filter changing was revised to have an eight filter motor-driven filter wheel. The filters finally used are given in the table.

Filter Characteristics

	Center	HBW	% Trans.	OH Band
1	Opaque - dark current			
2	690.1 nm	12.3	57	7-2
3	711.9	9.6	54	background
4	730.2	12.0	56	8-3
5	788.2	11.2	56	5-1
6	819.0	9.2	45	Background
7	840.6	12.4	52	6-2
8	720.0 cut on	100	90	Bandpass 720-900

A geneva drive continuously changed the filters with a 20-second dwell time on each.

EO training at UNM occurred in March with Nick Wells, Ken Dick, and Northrup Observer Norm Donnelley present. Due to very poor weather the training sessions had to be confined to the laboratory with the various instruments set up on tables. With EO inputs the operating instructions were revised considerably and a package of instructions and reprints were sent to the other EO John Beckman in Europe.

In an effort to shorten exposure times further we obtained and used Eastman Kodak Type 2475 oscilloscope recording film to replace our 4X Eastman film. This film rated at ASA 1250 performs somewhat better than the 4X rated at ASA 400, but the latter seems to have a wider latitude and can be pushed more in developing.

The equipment was installed on the aircraft with little difficulty but the first checkout flight provided many failures and problems.

a) A new Topcon Super Dm camera with motorized 250 frame back failed on the first roll of film. The drive gears stripped and it was not used during the remainder of the project. On the second checkout flight, the camera was operated manually with 36-frame roll film. Later a 250-frame Nikon loaned by Ames was used with no problems.

b) In the aircraft environment both image tubes exhibited a peculiarity in the form of non uniform response. This was lessened, but never eliminated, in subsequent flights.

c) A commercial time lapse sequencer for the 35-mm camera would not work at all on the aircraft, giving many spurious frame exposures. This unit was replaced by a 1-RPM motor and microswitch to trigger the 35-mm camera. The other sequencer for the movie camera unexplainedly blew fuses until it was operated through a Sola voltage stabilizing transformer.

d) Poor action, and slippage of the motor drive for the 16-mm camera was finally solved by wiring the universal joint together with spring steel wire.

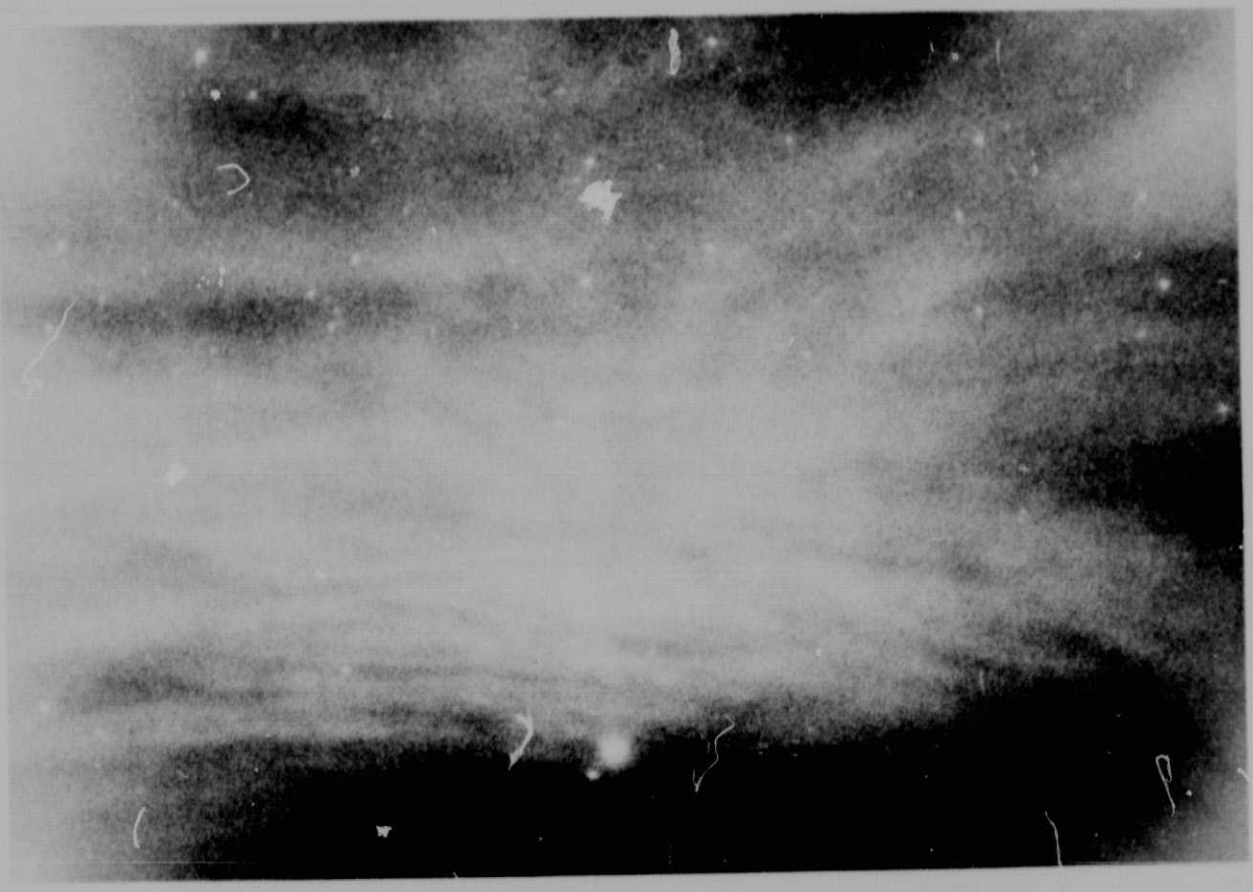
We awaited the debriefing of the first EO flight with much apprehension because of the large number of problems appearing in the first three flights. To our surprise and relief everything operated well and relatively failure free for the remainder of the flight series. Strip chart recorder pens not inking were one of the main problems.

Our data acquisition was somewhat limited by a) the large number of Venus runs during twilight, b) the numerous ρ Oph runs during which time our instruments viewed the very structured region of the summer Milky Way in Scorpio and Sagittarius, and c) by the presence of the moon on several of the flights. In spite of this and by utilizing both sides of the plane during non-simulation flights, we averaged more than 3.5 hours of data from each of all three instruments for the 14 flights. We removed our equipment on 18 June since no more flight time of the last two flights would be without twilight or moonlight.

Two examples of airglow photos are appended.

A short paper has been submitted for the special issue of Nature Magazine to be devoted to the Space Simulation Mission. A paper entitled "Observations of OH Airglow during Space Shuttle Simulation" was given at the 1975 Neighborhood Astronomers' Meeting at Lubbock, Texas on July 12, 1975.

Personnel active on this grant have been A. W. Peterson and L. M. Kieffaber. The instruments were constructed in the University of New Mexico, Physics Department, machine shop. The UNM Physics Department contributed about 2-man months of machine shop time to the project.



One second exposures from the CV-990 on the nights of 16-17 June (above) and 17-18 June, 1975 (below). Both are dodged to reduce vignetting.