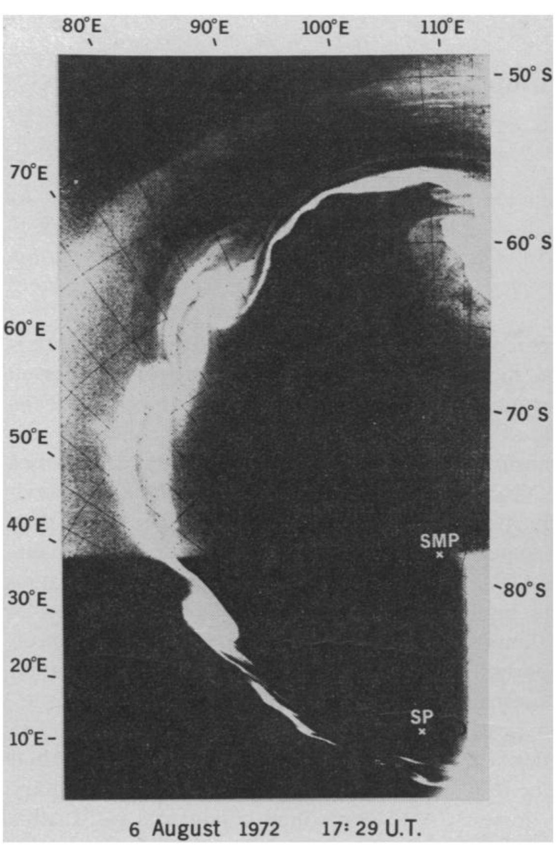
Reports

Auroral Photography from a Satellite

Abstract. *Photographs taken from satellites show the form, location, and intensity of the aurora from a new perspective. They provide an effective way of monitoring auroral activity on a worldwide basis and are likely to become one of the major tools in the effort to understand this phenomenon.*

Photographs taken from satellites are shedding new light on the extent and forms of auroral activity. The most exciting and spectacular aspects of these pictures are the large field of view, covering a large fraction of the auroral oval, and the coverage of otherwise inaccessible areas. Photographs presented here (cover photograph and Figs. 1 and 2) were obtained from U.S. Air Force Weather Service satellites. The image was produced by a line-scanning radiometer. The crosstrack scan was produced by a mirror rotating at 1.78 rev/sec. Because of the orbital motion of the spacecraft, adjacent scan lines along the track were separated by 3.7 km. The resulting photographs cover an area about 3000 km wide, in the general east-west direction. Their length is limited only by the data-handling capacity of the spacecraft. The spatial resolution is 3.7 km along the center of the strip; there is some degradation at the edges. The images are rectified, to remove geometrical foreshortening. These photographs are formed over a broad spectral band, composed of the visible and the near infrared regions. The spectral response peaks at 0.80 μm, and falls to 50 percent of peak response at 0.59 and 1.01 μm and to 1 percent at 0.40 and 1.15 μm. Thus this system integrates several auroral spectral features including the red lines (6300 and 6364 Å) and the green line (5577 Å) of O I, and a large fraction of the N_2 first positive and N_2^+ Meinel systems (*1*). Anger (*2*) has presented some scanning photometer data which are similar to the data presented here.

Feldstein and Starkov (*3*) have suggested that auroral activity occurs along an oval that surrounds the north geomagnetic pole and along a similar oval around the south geomagnetic pole. The position of the oval varies with geomagnetic activity. Its geomagnetic colatitudes are about 23° on the night side and 15° on the day side during periods of moderate geomagnetic activity (*4*). The concept of the auroral oval is dramatically shown in the down-looking photograph in Fig. 1. One half of the



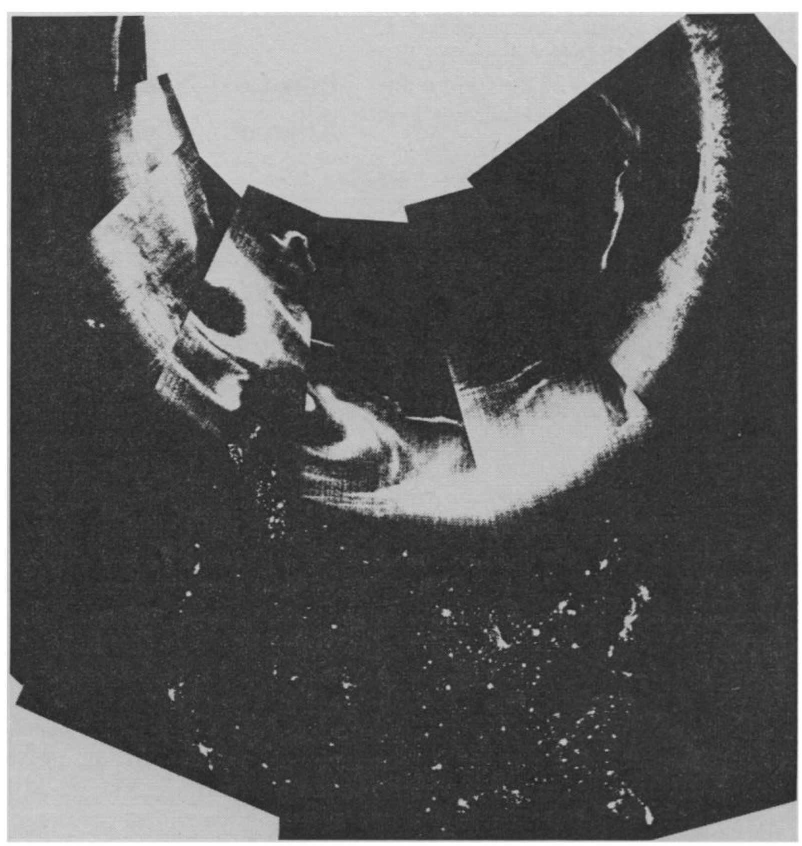


Fig. 1 (left). Rectified photograph of auroral activity southwest of Australia showing half of the auroral oval. Geographic coordinates including the South Pole (*SP*) and the south geomagnetic pole (*SMP*) are marked. The local time at the top of the photograph (101°E) is midnight; the local time at the bottom of the photograph is near noon. The discontinuity running through *SMP* is caused by an instrumental problem. The area covered is 2915 by 5145 km. Fig. 2 (right). Aurora borealis and the city lights of the United States and Canada on 14 February 1972. Seven consecutive photographs, each taken near local midnight, are overlaid to show more than half of the northern auroral oval.

southern oval, active along its entire length, is pictured. The aurora occurs at a geomagnetic colatitude of about 23° at the top of the photograph, where the local time is midnight, and at about 14° geomagnetic colatitude at the bottom of the photograph, near local noon. In such photographs it is quite common to see, as in Fig. 1, a dimmer, diffuse auroral form on the side away from the geomagnetic pole and brighter, more sharply defined features on the side toward the geomagnetic pole. The minimum detectable signal in these photographs is about 8.5×10^{-10} watt cm^{-2} $ster^{-1}$. The system saturates at 8.5×10^{-9} watt cm^{-2} $ster^{-1}$. These spectral integrated fluxes correspond to about 43 and 430 kilorayleighs, respectively, along the center of the strip. The slant path at the edges of the photograph in Fig. 1 causes weak layers to appear brighter there than at the center of the strip. An instrumental problem caused the base line to be shifted by an unknown amount in the lower part of Fig. 1, when the spacecraft was illuminated by sunlight, thus suppressing the dimmer auroral features.

The aurora frequently displays an eddy-like form with a characteristic length of a few hundred kilometers, which can be seen to some extent in Fig. 1. Hasegawa (*5*) has suggested that this may be the result of kink instability in the field-aligned sheet current proposed by Akasofu and Meng (*6*).

Seven consecutive photographs, each taken near local midnight, were overlaid to form the composite shown in Fig. 2. The interval between adjacent photographs is 102 minutes, which is the orbital period of the satellite. The continuity, or lack thereof, at the boundaries indicates the variability of auroral activity in 102 minutes. The general location and intensity are fairly constant from frame to frame, but one sees dramatic changes in the fine structure. The most widely used index of geomagnetic activity, K_p, had a value of 3+ during the two photographs on the right, taken over the Atlantic Ocean and the East Coast of the United States, decreased to 3 during the time when the two photographs over central United States and the West Coast of the United States were taken, decreased to 2+ during the next two photographs, over Alaska, and to 1 at the time of the photograph on the extreme left. The correlation of auroral activity, as recorded by these photographs, with K_p is thus crude. The photograph on the extreme left shows the least geomagnetic activity and occurs at the time of lowest K_p, but the photographs over Alaska and the western United States appear to have no less geomagnetic activity, perhaps even more, than those over the eastern United States and the Atlantic, which were taken when K_p was greater.

Even when the clouds are illuminated by moonlight, one can usually distinguished the aurora from clouds by its location and shape, as shown in the cover photograph. The moon was one day past first quarter and was almost directly overhead, at the equator, when the cover photograph was taken. One can also distinguish the aurora from clouds by comparing a photograph taken with visible light with a simultaneous thermal infrared image, in which clouds are generally visible but the aurora is transparent, as shown in the cover photograph. This comparison is useful even when the moon is located so that no moonlight is reflected from the clouds, because it sometimes happens that the reflection of bright aurora from clouds can be confused with dim aurora. Note the fjords of northeastern Greenland as seen by reflected auroral light in the cover photograph.

Photographs taken from satellites make it possible to monitor auroral activity on a global basis. In addition to yielding valuable insight into the nature of the aurora, this coverage will permit more meaningful correlation of ground-based and satellite-borne experiments designed to unravel this complex phenomenon.

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Low-Loss Niobium-Tin Compound for Superconducting Alternating-Current Power Transmission Applications

Abstract. *A Nb_3Sn superconductor has been fabricated in rods and tapes by the interaction of the tin contained in a copper-tin alloy with niobium which had been in contact with the alloy material. This conductor has lower alternating-current (60 hertz) losses than any presently available commercial products.*

The a-c loss of a type II superconductor at 60 hertz is one of the most important properties which determines the feasibility of using this material in superconducting a-c power transmission lines. The superconductor Nb_3Sn is of interest for this application primarily because it has a high superconducting transition temperature ($T_c \cong$ 18 K), a high critical field, and a high critical current density (*1*). Although the high critical current is important for overload conditions, for normal operation currents corresponding to peak surface fields of the order of 1000 oersteds are desirable. Under this operating condition, acceptable losses would be several $\mu w/cm^2$ (*1*).

The a-c losses and especially the effect of various metallurgical treatments on these losses (*2, 3*) have not, to our knowledge, been studied under conditions appropriate for this application. Out of the investigation reported here of the losses in Nb_3Sn has been developed a processing method for preparing Nb_3Sn conductors with losses that are substantially lower than previously available and that are more than adequate for the realistic designs discussed in (*1*). We report here a summary of this work.

To produce the required test specimens of Nb_3Sn, two fabrication methods were used: (i) "composite" and (ii) "tin dipping" processing. The first process is based on the method now used for making multifilamentary A-15 compound conductors (*4*). In this process a 0.64-cm niobium rod is inserted into a 1.27-cm copper-tin alloy tube approximately 15.3 cm in length, and this composite is then drawn to a 0.64-cm diameter. It is then sectioned