THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

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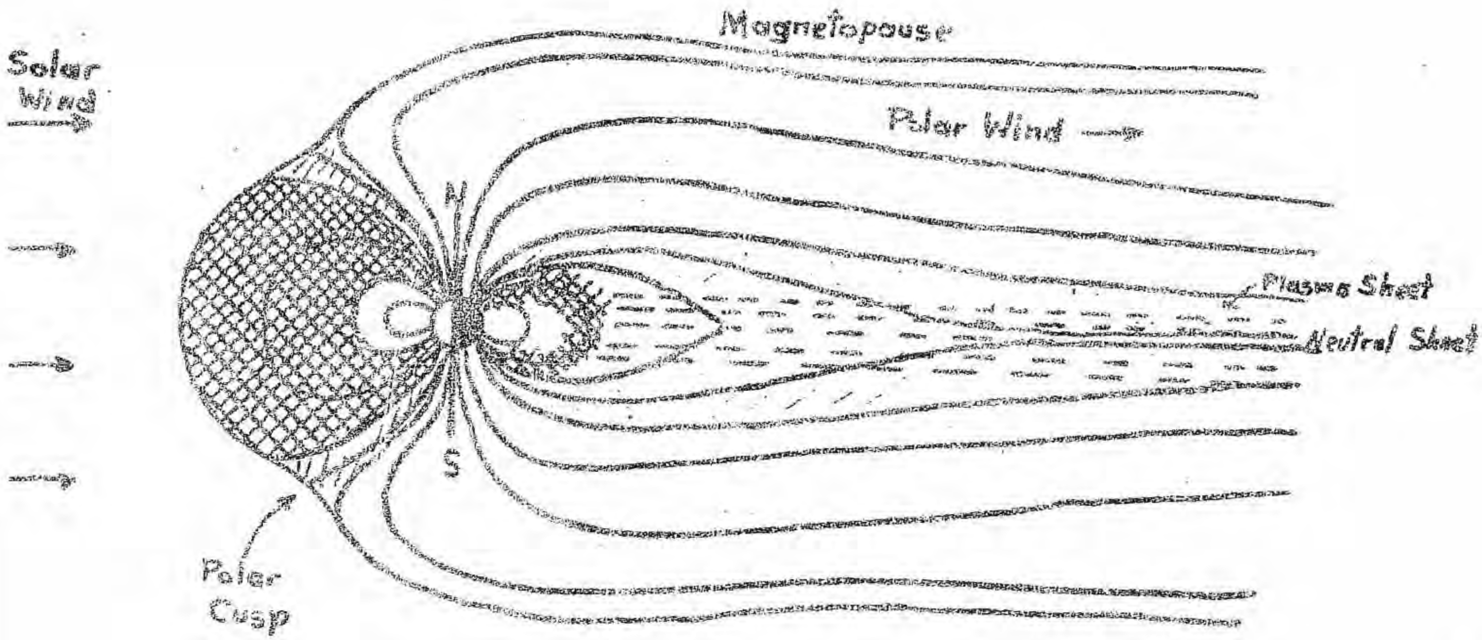
NEWSLETTER



THE DISTRIBUTION OF PLASMA IN THE MAGNETOSPHERE -- NOON-MIDNIGHT CROSS SECTION

Dr B.W.CURRIE, IMS Coordinator (Canada)

Our feature article this month, The International Magnetospheric Study, 1976-78, was prepared for our Newsletter by our Honorary President, Dr B.W. Currie, BSc, MSc (Sask), PhD (McGill) FRCS and Companion of the Order Of Canada.

Dr Currie is recognized internationally for his research on the upper atmosphere. He was a student at the University of Saskatchewan in the 1920s and joined the faculty as an instructor in 1928. He became Head of the Physics Department in 1952, Dean of Graduate Studies in 1959, and Vice-President of Research in 1967. He established the Institute of Space and Atmospheric Studies at this University and directed it for the next ten years.

Dr Currie has been named by the National Research Council of Canada to be the Coordinator for Canadian research activities in the International Magnetospheric Study (IMS) 1976-78. This is an international cooperative enterprise aimed at obtaining full understanding of dynamical processes in the geomagnetic field. It is an international plan of coordinated observations from spacecraft, research rockets, balloons and ground-based facilities.

Dr Currie brings to his present appointment not only his international reputation for research on the upper atmosphere, but also much valuable experience in involvement in International research ventures. He was active in the Second Polar Year 1932-33, spending this period at Chesterfield Inlet conducting magnetic and auroral observations. During the International Geophysical Year 1957-58, Dr Currie played a very active role in organizing the extensive auroral studies carried out across Canada with Saskatoon as the Data Centre.

The Saskatoon Centre is indeed greatly appreciative to have available this article prepared by such a well known and honored physicist.

Other Centres may use this article in their own Newsletters if they wish, provided that due recognition is given to Dr Currie and the Saskatoon Centre.

THE INTERNATIONAL MAGNETOSPHERIC STUDY, 1976-78

A two-year, international study of the space surrounding the Earth, threaded by its magnetic field lines or its magnetosphere, will start in January 1976. At least 50 countries will take part. The study is designed to resolve problems concerning the processes which take place in our magnetosphere due to the ionized gases ejected from the Sun and travelling out into interplanetary space as a solar wind. The Earth's magnetic field acts as a barrier to the incident ionized gases, or plasmas. On the side of the Earth toward the Sun during guiet solar conditions the Earth's magnetic field is compressed to within 8 to 10 earth-radii (E_r) of the Earth; during disturbed solar conditions when the solar wind increases in speed, to within 4 to 5 E_r. The solar plasmas are forced to flow around the Earth, and in doing so drag the Earth's field out into a long tail that may extend 80 to 100 E_r, and possibly more, from the Earth. Figure 1 shows three different concepts of the magnetosphere as deduced from spacecraft observations and theoretical considerations, and are taken from various scientific publications. One is three-dimensional; the other two are cross-sections.

The study is of interest to astronomers for two reasons, a) it may provide more exact information about the solar plasmas and the processes by which they are ejected, and b) it will provide information about the interaction of the solar wind with other planets and their moons which have magnetic fields. This part of the study, however, is secondary to getting a better understanding of our magnetospheric environment. It is within this space that electrically charged particles are apparently accelerated by electric fields induced by interactions between the solar wind and the magnetic field, and travel along magnetic field lines into the ionosphere at middle and higher latitudes.

One result of this earthward penetration of the particles (electrons and protons) that can be seen by all of us is the polar aurora. Electrons penetrating to heights between 80 and 1000 km above the surface of the Earth excite oxygen atoms and nitrogen molecules which then emit the characteristic spectral wavelengths of the aurora. Occasionally protons, or the nucleus of hydrogen atoms, penetrate roughly to the same levels, producing a reddish aurora referred to as hydrogen aurora. X-rays are also emitted and can be detected by suitable equipment carried to heights of 100,000 ft and higher by balloons.

This is only part of what is known as a geomagnetic substorm. Varying electric currents flow in roughly an east-west direction at the lower auroral levels. Their magnetic fields are superimposed on the normal geomagnetic field, and their locations and magnitudes can be deduced from the records of a line of magnetometers on the ground in a north-south direction in the region with the aurora. A practical concern of these magnetic field variations is the electrical potentials induced in the surface layers of the Earth. These potentials cause currents to flow through telephone and electric power distribution lines with "grounds". The former will "garble" conversations; the latter, on occasion, have "thrown" circuit breakers, burning out transformers and generators. These currents also heat the power transformers, causing the insulation on the wiring to deteriorate and eventually to fail so that there is a short-circuit.

A more serious effect of the increased ionization in the ionosphere is the interference with radio communication and radar detection of aircraft in and close to the region with a substorm. The radio waves travelling through the region may be absorbed so that there is a "black-out", or be absorbed and scattered intermittently so that messages and programmes are garbled. The auroral ionization will also scatter and reflect radar waves so it is difficult, or even impossible, to detect aircraft. When there are radar reflections from aurora, the aurora is usually called radio aurora.

It is also anticipated that the IMS will yield information on weather and climatic variations related to the sunspot cycle. Detailed studies over many years have shown that these variations are not due to any detectable changes in the amount of solar heat incident on the Earth. The alternative is a triggering of atmospheric variations by processes taking place in the near magnetosphere.

Above all, an understanding of magnetospheric processes is essential to the use of the near magnetosphere by spacecraft for communication, resource studies, and observations out into space, the last by a space shuttle to a suitably instrumental spacecraft. At least one spacecraft is assumed to have failed due to energetic solar particles.

The success of the IMS will depend on suitable observations in the magnetosphere by spacecraft coordinated with ground-based observations at latitudes where the effects of magnetospheric processes can be detected. Between 20 and 25 spacecraft will be circulating about the Earth measuring electric and magnetic fields, and the fluxes and energies of particles in the magnetosphere. Their data will be transmitted by radio to receiving stations on the surface, and deposited eventually in data centres where they can be used by space and magnetospheric researchers. Ground-based observations will be made by magnetometers, various spectral devices for detecting auroral and airglow radiations, all-sky auroral cameras, auroral radars, riometers, ionosondes, and rockets and high-flying balloons carrying devices to detect the terminal effects of particles penetrating into the ionosphere. Most of these data will be also eventually deposited in the data centres.

Canada has a major responsibility to participate in the IMS. No other country has a distribution of territory better suited for ground-based observations of the most disturbed part of the ionosphere due to interaction between the solar wind and the magnetosphere. Observations can be made all the way from middle latitudes to the neighborhood of the geomagnetic pole close to Alert in Ellesmere Island.

The most disturbed regions of the ionosphere are delineated by the auroral ovals. A diagrammatic sketch of an oval is shown in Figure 2. It is shown in latitude coordinates about a geomagnetic pole and time coordinates related to the Sun. The oval is appreciably shifted toward the dark hemisphere along the midnight meridian, and is broader on the midnight side than the noon side. Photometric photographs taken by the Canadian ISIS-2 satellite, photographs from aircraft flying along the oval and a U.S.A. satellite have confirmed that aurora can occur simultaneously all around an oval. The path traced out by the outer edge of an oval as the Earth rotates is the zone which corresponds to the maximum frequency of occurrence of aurora. It is here where the aurora associated with a geomagnetic storm usually first occurs. The path traced out by the inner edge of an oval bounds what is known as the polar cap. The magnetic field lines out of or into the Earth for the polar caps are believed to be "open" field lines which merge with the interplanetary magnetic field lines. Aurora observed from within a polar cap is notably different from that observed within and outside an oval.

Planning for Canadian IMS activities is still in progress. However, it is now certain that four lines of magnetometers will be operated wholly or in part on Canadian territory. One will pass through Churchill and along the west coast of Hudson Bay. Another will start from near Calgary, passing through Fort Smith and end to the Arctic Coast. Still another (a U.S.A. line) will start in southern Alaska and extend along the western side of the Canadian Arctic Archipelago to Ellesmere Island. The fourth line will be in an east-west direction and to the south of the zone of maximum auroral occurrence. The ISIS-2 spacecraft will continue its recording of auroral occurrence and of incoming particles which excite auroral emissions, or until such time as its equipment fails to operate. A number of expeditionary projects are in the planning stage. These include the use of rocket and balloon-borne equipment, auroral photometers, spectrometers and all-sky cameras, riometers, ionosondes, and auroral radars. Most of the expeditions will take place in the northern parts of the Prairie Provinces and along the Arctic coasts of Canada. A detailed description of these and how they relate to magnetospheric phenomena must be left for a later edition of our Bulletin.

B.W. Currie

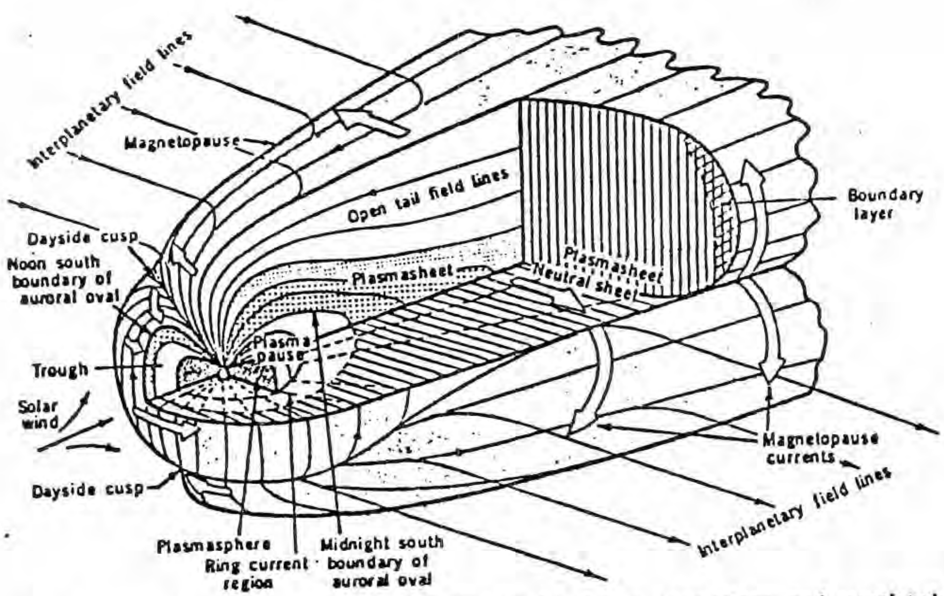
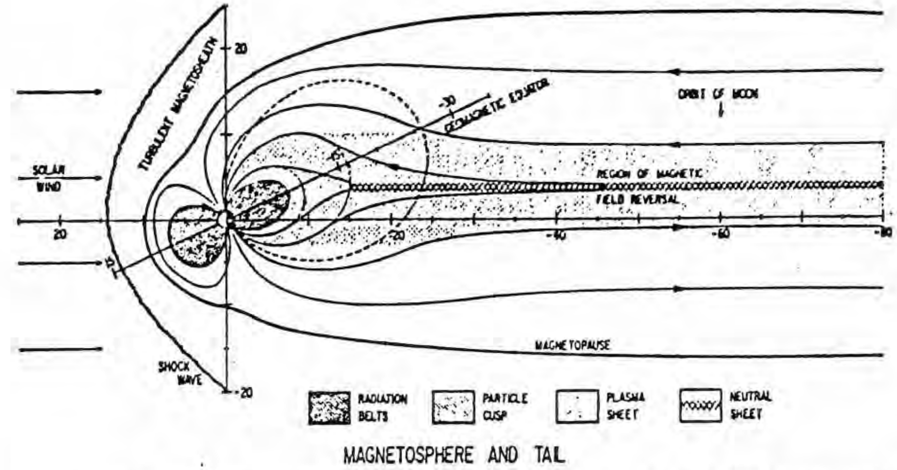
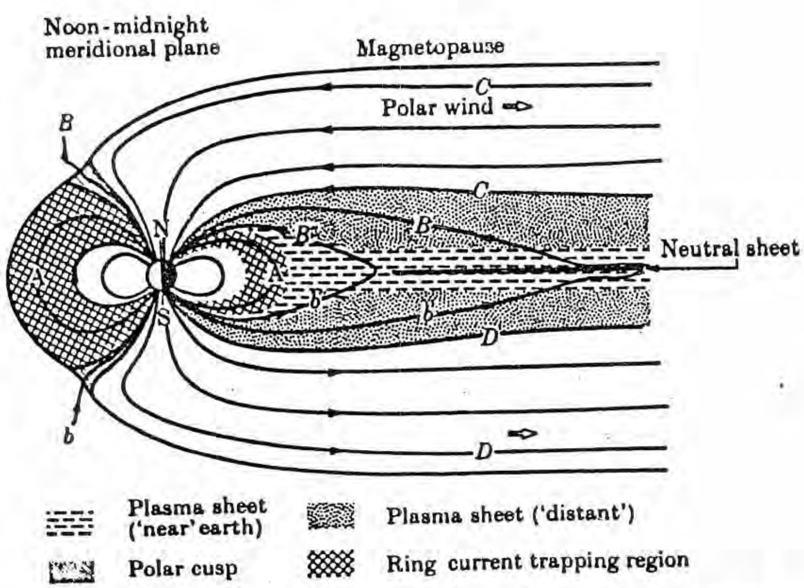


Fig. 1. Artist's conception of the magnetosphere, its plasma populations, and associated boundaries and currents (6).



Present-day view in noon-midnight magnetic meridian plane of the geomagnetic field and tail as distorted by the supersonic solar wind. A detached bow shock forms upstream from the magnetosphere and leads to the development of the turbulent boundary layer, the magnetosheath.



The distribution of plasma in the magnetosphere; the noon–midnight cross-section. After Frank (1971).

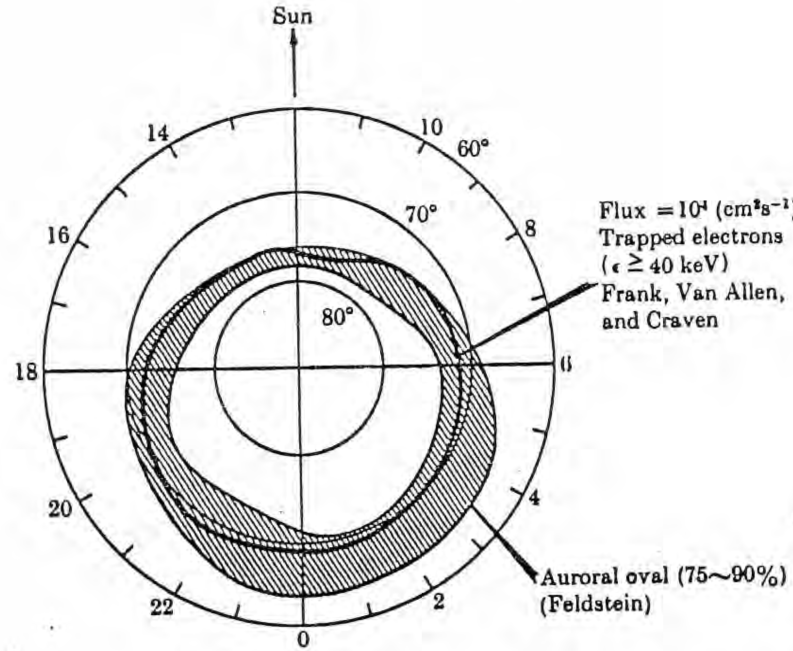


FIG. 2. The auroral oval in the dipole–time coordinates. The projection (along geomagnetic field lines) of the outer boundary of the trapping region onto the polar upper atmosphere is also indicated.

OBSERVER'S REPORT - UPDATE OF COMET KOBAYASHI-BERGER-MILON (1975h)

In our last issue of the Newsletter (August) we reported the independent sighting of Comet Kobayashi-Berger-Milon (1975h) by one of our members, Mrs Lillia Wilcox, on July 13th, ten days after it had been reported by a Japanese astronomer. A report of this sighting was forwarded to the Smithsonian Astrophysical Observatory and a reply was received from this agency confirming the sighting of this comet.

Since that finding, the active Observers Group has maintained a relatively continuous sighting and plotting program on this Comet which is due to reach perihelion on September 5th. As of the date of printing, 28 August '75, sightings have been obtained on 34 different evenings out of a possible maximum of 46. Cloudy weather prohibited sightings on the other twelve days. This program will continue as long as possible.

Parameters of Comet 1975h, as published by the I.A.U. are as follows:

Perihelion - 1975 September 5.3367 UT

Perihelion Distance - 0.425533 Astronomical Units

Inclination - 80.7741 degrees

Eccentricity - assumed to be parabolic, ie, Unity (1).

Magnitude Equation - $m_1 = 7.5 + 5 \log \Delta + 10 \log r$,

where Δ = distance from the Earth, and

r = distance from the Sun.

Until recently this comet has been relatively easy to find with a magnitude of 5. Its present manitude is about 4.5, but as it is rapidly approaching the Sun, it is now down in the twilight zone, and can only be seen for a short time after sunset in the North-western sky. It will soon disappear in the twilight, but should re-appear after perihelion passage in the eastern sky ahead of the Sun, and moving gradually southward. It is doubtful if it will be visible before September 12th or thereabouts.

REPORT ON THE SASKATOON CENTRE FIELD OUTING

Another field outing has come and gone, and except for persistent cloud (!#!!), it was very succesful. The first three cars to arrive at the farm did not stop off at the Observatory to pick up members as they were loaded to the hilt with telescopes and associated astronomical paraphernalia. Besides this, they had to get out there early to set up. By the time these three were unloaded, there were already seven telescopes set up. Those being Mr Patterson's Celestron 8, his big sky camera, the 6" reflector from the Observatory as well as the old 4" refractor, Jim Young's 6" reflector, Lillia Wilcox's 2.4" refractor , and Doug Beck's telescope. After we were finished we went in the house to chat with the Aucklands and wait for the rest to arrive. Soon more cars came and Halyna Kornuta arrived with the "essentials," coffee, hot chocolate, hot dogs, etc. The Aucklands were then presented with a gift from the Centre consisting of a Handbook, a star finder, a messier chart, and some pamphlets. Once everyone came there were almost 20 people there if not more. Only one car got sidetracked enroute but they eventually arrived with a long story of their adventures.

As the night progressed a small part of the sky cleared to the southwest and we did see a star now and again, but it never cleared to any extent of being able to do any serious astronomy. We all sat around talking, hoping that it would clear up - but no go. All we saw during the night was the Trifid Nebula (through a hole in the clouds.) At about 2 am we had some more hot dogs, complemented by some donuts which Lillia Wilcox brought out. Everyone then took their last look at the Aurora Saskatonius as we decided to call it quits as the clouds did not want to cooperate with us.

Although we did'nt see much, I believe everyone there enjoyed themselves fully. A sincere thankyou goes to Mr & Mrs Auckland for their cooperation and effort once again.

As per usual, it began to clear soon after we arrived back in Saskatoon!!

THE ROYAL ASTRONOMICAL SOCIETY 1968
SASKATOON CENTRE

MEETING NOTICE

Place ....ROOM B111, HEALTH SCIENCES BUILDING....

Date ....TUESDAY, 16 AUGUST, 1975....

Time ....8:00 pm....

Purpose .REGULAR BUSINESS FOLLOWED BY FILMS....