Using observations made at Seattle and Stanford, D. L. Carpenter, of Stanford University, California, was studying whistlers. Audio-frequency electromagnetic radiation from lightning discharges, which penetrates the lower ionosphere and is guided from one hemisphere to the other by ducts of enhanced plasma density, which are themselves field-aligned, suffers dispersion. The characteristic signature of the whistler in the frequency-time domain is thus explained. As in much of geophysics, the received signal is the result of integration of a weighted varying physical parameter over the propagation path, and has to be interpreted either by comparison with model computations or by inversion. Using the former method with multipath whistlers, Carpenter showed that the plasma density profile in the equatorial plane decreases smoothly out to $L \sim 4$. There the profile often exhibits a 'knee'; the plasma density decreases sharply, within a fraction of an Earth radius, by an order of magnitude or more, to only $\sim 10^7\ m^{-3}$. (Carpenter's knee is now termed the plasmapause). He also showed that the plasmapause persisted for several hours at least, and that its L-value was a maximum at dusk, at the bulge in the plasmapause.

K. I. Gringauz, of the Space Research Institute of the USSR Academy of Sciences, Moscow, was studying measurements made by "charged particle traps" carried on the Luna (Lunik) 1 and 2 rockets launched to the Moon. These can be interpreted to yield positive ion density values at intervals along the spacecraft trajectory. With coworkers, he found that the plasma density could suddenly decrease markedly on the outgoing part of the trajectory.

Thus these *in situ* observations confirm the 'remote sensing' whistler observations. The results obtained by one technique complement those obtained by the other. The power of one method (low cost and good temporal coverage for example) is offset by the serendipity of whistler occurrence and their time-consuming analysis. The power of the other method (unambiguous measurement at a point in space) is offset by the high cost of satellite experiments and the fact that many hours—or even days—pass between successive observations at neighbouring points on a particular L-value. In the intervening time, the plasma density may have changed—by an order of magnitude—due to dynamical processes.

A symposium on the Physics of the Plasmapause was held in Trieste in September 1974, under the aegis of the European Geophysical Society. In a special issue of the journal *Annales de Géophysique* (**31**, No. 1, 1975), both invited review and contributed papers were published. The subjects covered ranged from peculiar features of the mid-latitude ionosphere associated with the plasmapause to energetic charged particle phenomena, and included treatments of geomagnetic pulsations observed at $L \sim 4$ and of some relevant theoretical problems.

The variations of the L-value of the plasmapause with changing geomagnetic activity (which follows changes of parameters of the solar wind) and at different local times have been investigated by several authors. Most recently N. C. Maynard and J. M. Grebowsky, of the NASA Goddard Space Flight Center, Maryland, have performed such a study based on observations taken aboard the Explorer 45 (or S^3-A) satellite. It is curious and, in retrospect, unfortunate that this satellite did not carry an instrument to measure the plasma density directly. However, an instrument to measure the d.c. electric field responds, at low plasma densities, to potentials associated with the Debye sheath around the satellite. As the satellite moves in its 7 h 49 min orbit outwards in the equatorial plane, towards its apogee at a geocentric distance of 5.24 Earth radii, it crosses the plasmapause; there the instrument becomes saturated due to these sheath potentials. Using coincident ground-based whistler and Explorer 45 observations, M. G. Morgan and Maynard (*J. geophys. Res.* **81**, 3992; 1976) showed that saturation occurred at a plasma density of $6\times10^7\ m^{-3}$, to within a factor of two.

In a recent paper, 'The plasmapause revisited' (*J. geophys. Res.* **82**, 1591; 1977), Maynard and Grebowsky have studied statistically the plasmapause position. They have used observations taken over 15 months and covering 1972 completely. The local time coverage was from 2300 LT, through noon to 0800 LT. They found that the plasmapause bulge occurs at 2000 or 2100 LT at geomagnetically quiet times, but migrates towards 1800 LT as magnetic activity increases. During quiet periods, a secondary bulge near local noon is found, confirming results obtained recently by K. I. Gringauz and V. V. Bezrukikh.

Observations of the variation of the plasmapause position with both local time and geomagnetic activity have been interpreted in recent years in terms of the electric field within the magnetosphere. This results from the superposition of the electric field representing the corotation of the inner magnetospheric plasma with the Earth, 'tied' by the geomagnetic field lines, and the electric field resulting from the flow of the solar wind past the magnetosphere which drives the convection of the outer magnetospheric plasma from the night-side to the day-side in the equatorial plane. This latter field may be at least partially 'shielded' from the day-side of the Earth, for example by the shorting-out action of the highly conducting, sunlit ionosphere or by the build-up of space charge layers. The fact that the bulge moves towards dusk, with increasing magnetic activity, indicates that this shielding becomes less effective for the larger convection electric fields occurring then. The secondary bulge in the plasmapause near noon can be explained by the projection of the S q dynamo electric field, in the ionosphere, along geomagnetic field lines into the magnetosphere.

Maynard and Grebowsky note that the plasmapause L-value is rather better ordered when plotted against *Dst*, the index of ring current intensity, than when plotted against K_p, the three-hourly, global (planetary) index of geomagnetic activity. This may be explained either by the plasmapause controlling the loss of ring current ions, by way of an ion-cyclotron resonance (loss-cone) instability, or by both the plasmapause and the energetic ring current ions responding together to changes of the convection electric field.

For the future, work remains to be done in the realm of plasma physics, to improve our understanding of the behaviour of the plasmapause as a boundary layer between cool and hot plasmas. The importance of the plasmapause in controlling wave-particle interactions, between whistlers and energetic electrons for example, or between ion-cyclotron waves and multifarious ions, is becoming recognised more and more. Now is the era when we can test the hypotheses that we have developed for the Earth's magnetosphere by applying them to exciting new observations of planetary magnetospheres. Whether or not we have to make reappraisals will remain to be seen. □

A hundred years ago

ON FRIDAY night a series of interesting experiments with the Jablochkoff electric light took place at the West India Docks, under the direction of M. Denayrouze. The apparatus used for the occasion consisted merely of an electro-magnetic machine worked by a small steam-engine, some insulated wires, and the electric candles, which are the invention of M. Jablochkoff, and composed, as we have already described, of two carbons placed side by side with a slip of insulating substance between them, which burns away with the carbon exactly in the same way as the wax of a wax candle is consumed with the wick.

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