Research Highlights

THE AUSTRALIAN NATIONAL UNIVERSITY

Unraveling the Enigma of Auroral Excitation

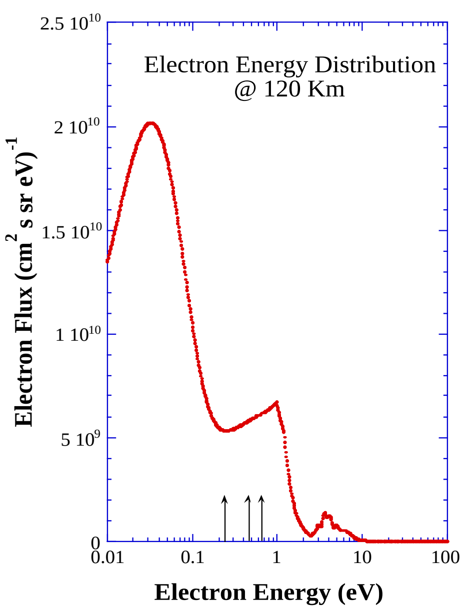
Steve Buckman and Milica Jelasavicic

Steve Buckman and Milica Jelasavicic in the laboratory

The spectacular shows of the Earth's aurora are driven by processes that occur in the rarefied atmosphere, 120 km above the earth. Here, in the ionosphere, interactions between electrons, ions, atoms and molecules lead to excitations of molecules, which then produce the colourful displays of auroral light as they de-excite.

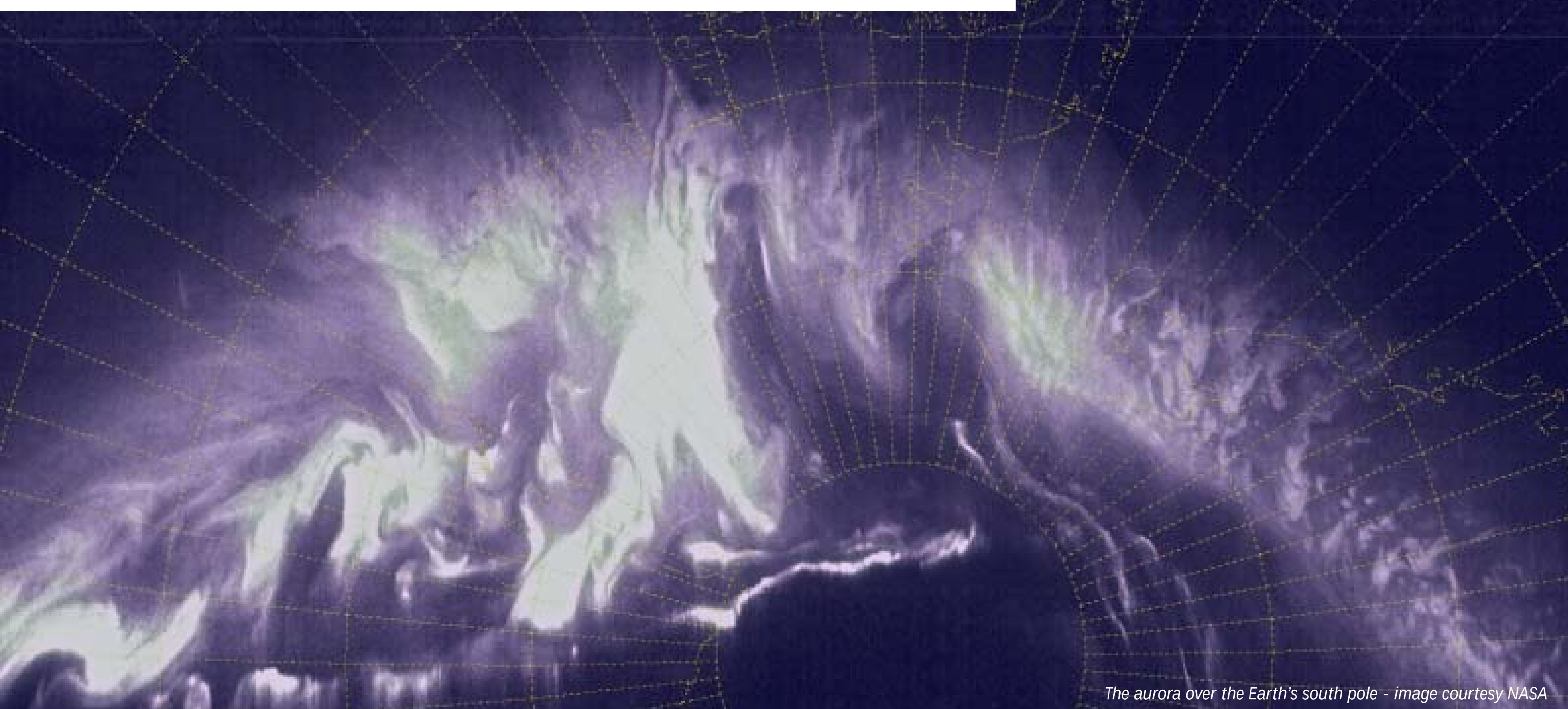
The nitric oxide (NO) molecule is only a minor constituent of the Earth's upper atmosphere. Nevertheless, it plays a major role in infrared auroral emissions due to radiation from vibrationally excited (NO*) states. Until recently it was thought that these NO* states were created by excited nitrogen atoms combining with oxygen. However, new work at the ANU (in collaboration with Flinders University) indicates that energetic electrons impacting unexcited NO molecules are also responsible for creating the excited NO states.

The electron energy distribution in the upper atmosphere has a peak, which by a strange coincidence, overlaps with the excitation of the vibrational modes of the NO molecule. The practical upshot is that there is a large population of electrons able to strongly interact with NO. These interactions, which only last for less than a million, millionth of a second, leave the NO molecule excited and with surplus energy which it is able to release as part of the spectacular auroral light display. ANU Scientists were able to deduce this by careful studies of the interactions of electrons and molecules in laboratory experiments, coupled with complex theoretical modelling of the atmospheric behaviour of NO carried out at Flinders.



The electron energy distribution with arrows showing the threshold energies for the first three vibrational modes of the ground state of the NO molecule.

Studies of such interactions between electrons and molecules have wider application than atmospheric physics. They are important in understanding many environmental, biological and technological processes. Better understanding of such events on the microscopic quantum scale can often lead to improvements in large scale industrial processes which are of great economic and environmental value.



The aurora over the Earth's south pole - image courtesy NASA

Research School of Physical Sciences and Engineering