Figure 1 | Spot the diffuse aurora. The discrete aurora includes the spectacular curtains and rays seen on the left and centre of this image. At the bottom right is the diffuse aurora, a faint green cloud that lacks the dynamic changes in intensity and morphology of the discrete aurora. However, the diffuse aurora actually contributes more to the global energy budget of the upper atmosphere than does the discrete aurora because of its persistence and geographical extent. Thorne and colleagues[1] demonstrate that a type of plasma wave called a chorus wave keeps the diffuse aurora going. (Photo courtesy of M. Yamaguchi, Swedish Institute of Space Physics.)

and geographical extent. It reduces the accuracy of navigation using the Global Positioning System, affects upper-atmospheric, high-latitude chemistry (for example, it produces copious quantities of nitric oxide), and is in fact largely responsible for creating the ionosphere during darkness, when solar ultraviolet light can't do the job of separating electrons from neutral atoms.

In recent years, and largely on the basis of theoretical studies, two distinct types of plasma wave — electrostatic electron cyclotron harmonic (ECH) waves and whistler-mode chorus waves — have been the leading candidates for the source that keeps the diffuse aurora going. But uncertainty has persisted because of the intricacies of the problem. Most researchers assumed that both types of wave contributed substantially. Rather surprisingly, Thorne *et al.*[1] have been able to provide a fairly definitive answer to the contrary.

To do so, they combined advances that included observations, theory and modelling. The satellite CRRES has gathered detailed data on the power of plasma waves. But more work was needed, including detailed electron-scattering calculations. Doing those correctly, in turn, requires knowledge of how the waves propagate (ray tracing). Thorne and colleagues have managed to put all of these pieces together and to produce detailed simulation results clearly showing that chorus waves can scatter enough electrons to maintain the diffuse aurora, and that ECH waves cannot. But how do we know that these calculations and simulations can be trusted?

The proof is in the details. First, the results correctly predict the gross morphology of the diffuse aurora, including its peak in the midnight-to-dawn sector. Perhaps even more convincingly, the calculations actually account for the observed fine details of the electron pitch-angle distributions. In fact, the new work can account for differences in lower- and higher-energy particle behaviour over a wide range of pitch angles. Thorne and colleagues seem to have provided a compelling answer to the question of why the bulk of auroral energy precipitating into the ionosphere occurs when and where it does, and why electrons in the magnetosphere are distributed in pitch angle in the way that they are.

In the 1950s, early rocket shots into the auroral ionosphere recorded intense emissions from plasma waves that had frequencies of between a few hundred and several thousand hertz, with complex changes in both intensity and frequency occurring over a fraction of a second. This reminded their discoverer, Storey[3], of a chorus of birds at dawn. Now, more than half a century later, Thorne and colleagues have shown that it is this 'chorus' that keeps the diffuse aurora humming. ■

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1. Thorne, R. M., Ni, B., Tao, X., Horne, R. B. & Meredith, N. P. *Nature* **467,** 943–946 (2010).
2. Newell, P. T., Sotirelis, T. & Wing, S. *J. Geophys. Res.* **114,** A09207, doi:10.1029/2009JA014326 (2009).
3. Storey, L. R. O. *Phil. Trans. R. Soc. Lond. A* **246,** 113–141 (1953).

50 Years Ago

The discovery that some errors of sexual development and other congenital defects in man were associated with karyotypic abnormalities has aroused considerable interest, and research in this field is growing rapidly … Various systems of numbering of the chromosomes have been used by different research groups, making the comparison of their results difficult. A meeting with the object of trying to devise an agreed nomenclature was therefore arranged by Dr. T. T. Puck, of the University of Colorado, and held in Denver during April 9–11 … A system was agreed on and a statement embodying it and other information relating to the identification of human mitotic chromosomes has been published (*Lancet*, i, 1063; 1960) … It is hoped that the proposed standard system will be generally adopted, and that any who may prefer to use another scheme will refer to the proposed system and show clearly in what way their own system differs.
From *Nature* 22 October 1960

100 Years Ago

Fellows of the Zoological and other scientific societies, museum officials and others, are warned against an individual representing himself as a consumptive and asking for a recommendation to a hospital and temporary help. The *modus operandi* is to call upon you with a bogus introduction from another fellow of your society or someone known to you, and to mention a few other well-known persons as interested in his case. The individual is rather tall, thin, of wan appearance, and has a dark moustache. His manner shows some refinement and education, and is also persuasive, as proved by the number of those known to have, unfortunately, been victimised by his false representations.
From *Nature* 20 October 1910