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Visible Discharge near an Active High-Frequency Dipole in the Ionosphere

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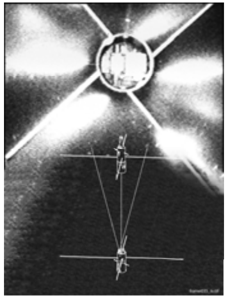
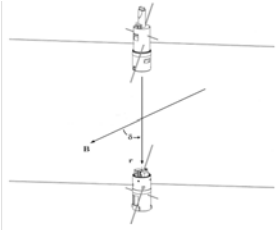
Two image-intensified television cameras with a spectral response between 400 and 900 nm were installed on the OEDIPUS-C (OC) sounding rocket double payload, which was launched into the auroral ionosphere on 7 November 1995. The primary role of the television camera on the lower, aft part of the payload was to capture black-and-white images of the upper, forward part of the tethered double payload against the star field. The TV images provided data for determining the absolute attitudes of both subpayload parts and of their separation direction throughout the flight. This objective was met completely. The angle between the separation direction between the two subpayloads and the axis of the Earth's magnetic field throughout the observations under consideration was less than 1º.

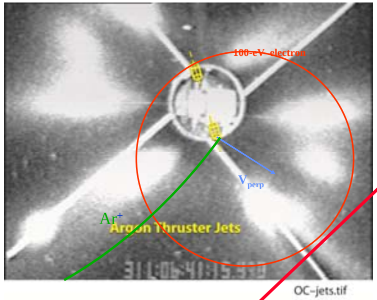
During the rocket trajectory up-leg, the aft television camera also observed luminosity in the neighbourhood of transmitting dipole antennas on the forward subpayload, immediately after the separation of the two subpayloads. The source of the luminosity was Argon atoms released during the 15 seconds of operation of an Argon gas separation thruster system. The optical emission was also limited to times when the dipoles were being excited by a 10-W radio-frequency (RF) transmitter. Emission intensity varied systematically with the transmitter frequency as it was swept from 0.025 to 8.000 MHz.

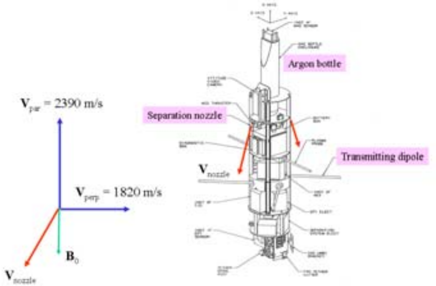
Sounder-accelerated electrons (SAEs) were observed over all detected energies (20-20000 eV) of Energetic Particle Instruments (EPIs) on both subpayloads. These EPIs observed SAE fluxes when the transmitter pulse frequency was at a harmonic of the electron cyclotron frequency. The detailed dependence on transmitter pulse frequency of the luminosity is used to support the view that the luminosity results from the collisional excitation by SAE of ArI and ArII atomic levels that subsequently decay by transitions at visible wavelengths.

OEDIPUS-C
Rocket upper subpayload seen from lower subpayload

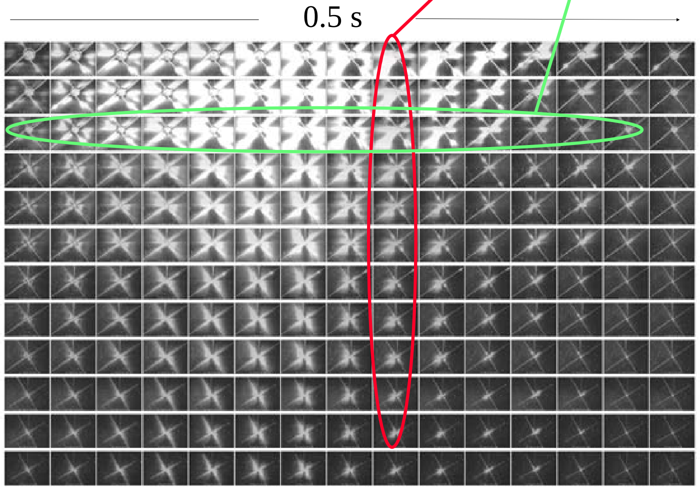




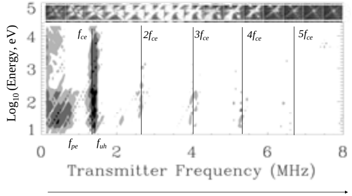




Luminosity disappears 15 s after separation , i.e., after evacuation time, so the light is excited Argon.
Xybion video camera records in 400-900 nm.
ArI line cross-sections for collisional excitation around 800 nm are much stronger than ArII lines.
Compare image sequences: see little spin modulation.
Compare images in one sweep: see some freq. dependence.
Suppose that $|\mathbf{V}_{nozzle\text{-}perp}| << |\mathbf{V}_{perp}|$.
Deduce that luminosity is ArI spectrum, e.g., λ = 811.53 nm, E_{th} = 13.1 eV, Q^{opt}(25 eV)=932. x10^{-20} cm^2, [Boffard et al., *At. Data Nucl. Data Tab.*, 2007].



Are Ar atoms excited by sounder-accelerated electrons during 0 – 8 MHz sweeps? Possibly.



Movie available

Note: Author may be at Poster Z151

Steps to Explaining the Luminosity:

Calculate near EM fields, possibly using “COMSOL Multiphysics”.
Explain energization process and fluxes of Sounder-Accelerated Electrons.
Determine the density of Argon in the thruster plumes.
Using SAE fluxes, Ar collisional excitation cross sections, compute luminosity.
Consider star occultations for checking absolute luminosity.