Temperature and density measurements using the electron beam fluorescence technique in the upper atmosphere

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There are a few techniques for measuring temperature in the lower thermosphere (90 - 150 km altitude) and the existing temperature data is uncertain mainly because of experimental problems.

We applied the electron beam florescence (EBF) technique, which is widely used for temperature measurements in the laboratory, to in situ measurement and developed a rocket-borne instrument usable up to an altitude of 150 km. The EBF technique uses a high-energy electron beam to excite a gas molecule by an inelastic collision with an electron. Spectrum of subsequent fluorescence by the excited molecule consists of many vibrational bands, and each band has a fine rotational structure. If the excitation-emission process is known precisely, the analysis of the vibrational-rotational band provides properties of the initial state of molecules: vibrational temperature, rotational temperature, and number density of the molecules.

The instrument consists of two parts: an electron gun to excite and ionize ambient N2 and a sensitive spectrometer to detect the fluorescence of the N2+ first negative system. The electron beam from the electron gun is emitted in a direction perpendicular to the rocket axis and the line of sight of the spectrometer is tilted away from the rocket axis, thus the measurement volume is located at the intersection of the electron beam and the field of view of the spectrometer. A beam collector supported by the boom collects the electron beam.

This paper reports on the process of the development for three flight experiments and future possibilities of this instrument.