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Title: Direct measurements of the helium photoionization rate from sounding rockets

Source: Journal of Geophysical Research (June 1, 1997), vol.102, no.A6 p. 11557-66

Abstract: A method of directly measuring the absolute helium photoionization rate coefficient independent of detailed solar EUV spectra and photoionization cross sections has been demonstrated. Three such measurements were obtained using windowless rare-gas ionization cells operated in an optically thin mode. The cells were launched on Nike/Terrier boosted Black Brant sounding rockets from the White Sands Missile Range in 1983, 1989, and 1990. The rate coefficients were determined for altitudes from 150 to 330 km and were extrapolated to give values of $11.1 \times 10^{-8} \text{ s}^{-1} \pm 11\%$, $21.3 \times 10^{-8} \text{ s}^{-1} \pm 16\%$, and $13.2 \times 10^{-8} \text{ s}^{-1} \pm 11\%$ at the "top" of the Earth's atmosphere. The solar activity levels were characterized by absolute $F_{10.7}$ values of 119, 172 and 142 ($10^{-22} \text{ W m}^{-2} \text{ Hz}^{-1}$), respectively. The top of the atmosphere solar EUV flux values inferred from the measured ionization rates were found to be consistent with absolute flux measurements obtained simultaneously with a neon ionization cell operated in the optically thick mode.

Language: eng

Pub. Type: Journal Paper

References: 50

ISSN: 0148-0227