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# The Emission Intensity Ratio for O(1S) Transitions

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The O(1S) state has the important characteristic that emission from this level can follow two pathways, generating both the optically-forbidden 297.2 nm trans-auroral and the 557.7 nm green lines. As they share the common O(1S0) upper level, the observed emission intensity ratio of the two lines is a constant, equal to the ratio of the respective transition probabilities. Because a UV/visible spectrometer in orbit can detect both lines, the fixed value of the intensity ratio can be used as a two-point intensity calibration of the system sensitivity. If the known ratio of the two lines is not as measured, then the calibration is not correct. In Table 1 we show two sets of data, those obtained for the ratio by calculation, and those found by observation from space vehicles.

Table 1. Theoretical and Observational Determination of the OI 557.7/297.2 nm Intensity Ratio

Theory
Condon, 1934 11.1
Pasternack, 1940 24.4
Garstang, 1951 16.4
Yamanouchie and Horie, 1952 30.4
Garstang, 1956 17.6
Froese Fischer and Saha, 1983 13.6
Baluja and Zeippen, 1988 13.0
Galavis, et al., 1997 14.2
Froese Fischer and Tachiev, 2004 16.1
NIST recommendation 16.7

Nightglow
Sharp and Siskind, 1989 ∼9
Slanger et al., 2006 9.8 ± 1.0
Gattinger et al., 2009 9.3 ± 0.5
Gattinger et al., 2010 9.5 ± 0.5

We see that the values of the ratio are quite different, that for
the NIST recommendation being higher by 75% than the consistent space-based values measured in recent years. Because of the long history of the calculations, aeronomers have typically used the calculations when comparing visible and UV intensities, but we can now claim that the experimental values are to be preferred.

Theoretical calculations of the structure of neutral species are notoriously difficult. Quantum chemistry methods typically rely on variational optimization of the energies of the electronic states, using trial wavefunctions represented by sums over numerous electronic structure configurations, each consisting of products of electron orbitals, each of which is, in turn, expressed as a sum over numerous spatial basis functions. Exploratory calculations for the O(1S) forbidden emission strengths suggest that the convergence of expansion is exceedingly slow. More careful effort will be needed to calculate reliable numbers. We conclude that the observed transition probability ratio should be accepted as the basis for a space-based two-point calibration for optical instruments operating in the 290-560 nm region.

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