Highly Depleted Ethane and Slightly Depleted Methanol in Comet 21P/Giacobini-Zinner: Application of Empirical g-factors for CH$_3$OH near 50 K

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We report high resolution ($\lambda/\Delta \lambda \sim 24,000$) observations of Comet 21P/Giacobini-Zinner (21P) between $\sim 2.85 - 3.54 \mu$m, obtained with NIRSPEC at Keck 2 on UT 2005 June 03 ($R_h = 1.12$ AU, $\Delta = 1.45$ AU). These simultaneously sampled multiple emissions from the $v_7$ band of C$_2$H$_6$ and the $v_2$ and $v_3$ bands of CH$_3$OH, together with several hot bands of H$_2$O, permitting a direct measure of parent volatile abundances in 21P. Our spectra reveal highly depleted C$_2$H$_6$ (0.13-0.14 percent relative to H$_2$O) and CH$_3$OH/C$_2$H$_6 \sim 10$, consistent with previously published abundances from observations in the IR [1,2] and millimeter/sub-mm (reporting CH$_3$OH/H$_2$O [3]) during its previous apparition in 1998.

We observed similarly high CH$_3$OH/C$_2$H$_6$, and also similar rotational temperature to that measured for 21P, in Comet 8P/Tuttle [4,5]. We used our (higher signal-to-noise) NIRSPEC observations of 8P to produce effective (empirical) CH$_3$OH g-factors for several lines in the $v_2$ band. These will be presented together with interpretation of our results, including constraints on the spin temperature of water. We acknowledge support from the NASA Planetary Atmospheres, Planetary Astronomy, and Astrobiology Programs and from the NSF Astronomy and Astrophysics Research Grants Program.