Investigating Ammonia Gas in the Jovian Atmosphere using Centimeter Wavelength Total Flux
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We obtained flux density measurements of Jupiter taken by the Sunyaev-Zel'dovich Array (SZA) subset of the Combined Array for Research in Millimeter-wave Astronomy (CARMA) during a 2014 CO power spectrum survey (Keating et al 2016, arXiv:1605.03971v2). From these, we generated 15 time-averaged brightness temperature measurements between 27 and 35 GHz, with values ranging from 141 to 150 K and typical error bars of ~4 K.

These measurements were made with a compact array configuration, which is sensitive to the large scale disc-averaged flux density of the planet. With the SZA in this configuration, we are able to ascertain the total flux density of the source to a high degree of accuracy. We subtracted off synchrotron radiation based on a model presented by J. Gibson in order to isolate thermal emission, converted to brightness temperature, and added back the missing CMB radiation blocked out by the planet (Gibson et al 2005, Icarus 173:439-446). The 15 resulting brightnesses fall into a neatly packed group showing a gentle slope away from a prominent ammonia absorption line. While this domain contains several extant measurements from past studies, the accuracy and self-consistency of this set is unique to the region.

These thermal radiation measurements can be used in conjunction with an atmospheric radiative transfer modeling software and the other local measurements in order to find a consistent model of the relative abundance of ammonia gas in the troposphere at $0.5 < P < 2$ bars. Our current models are primarily generated by matching brightness models to this data set and a set from the Wilkinson Microwave Anisotropy Probe (WMAP) mission, which comprises 7 brightnesses between 22 and 94 GHz (Weiland et al 2011, ApJS 192:19). The wide range of frequencies covered by WMAP and the clean slope of our tightly-packed measurements serve as a clear target for these models. Preliminary results suggest a slight subsaturation of ammonia gas, at about 80% of the solar value. Further investigation will include other extant measurements and attempt a closer model fit to the data.