

# *Zspectrometer*: an Ultra-wideband Spectrometer for the 100-meter Green Bank Telescope

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## Abstract

We propose to construct the *Zspectrometer*, an ultra-wideband radio spectrometer for the Green Bank Telescope (GBT). Observations with this instrument are key to understanding the star formation, metal production, and structure formation histories of the Universe.

The *Zspectrometer* covers the full 14 GHz-wide Ka-band with a set of analog lag correlation spectrometers in a multi-channel correlation radiometer architecture. Its bandwidth and stability, combined with the GBT's collecting area, enable sensitive and efficient spectral searches for molecules in high redshift galaxies. The instrument is optimized for observations of low-excitation spectral lines from the carbon monoxide (CO) molecule at redshifts of  $1.88 \leq z \leq 3.43$  and  $4.76 \leq z \leq 7.87$ . This range of redshifts is of intense current interest because it may correspond to the era when most of the stars in the Universe formed and galaxies assembled.

All high-redshift radio molecular detections to date have started from optical redshifts. *Zspectrometer's* wide bandwidth bypasses this selection effect and enables it to detect new classes of sources. In addition to finding precise redshifts, its spectra with velocity resolution of approximately  $150 \text{ km s}^{-1}$  probe kinematical signs of interaction and derive dynamical mass estimates. Both cold and warm gas emit low- $J$  lines, and these observations are critical constraints on radiative transfer models of physical conditions.