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Building A Dedicated Radio Supernova Search Engine

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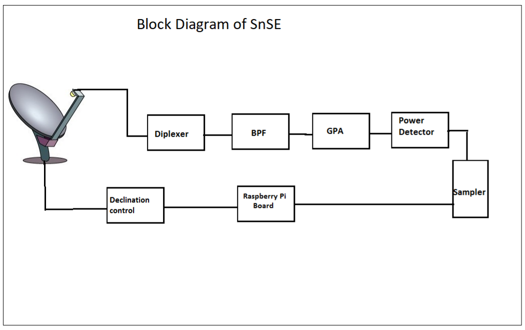
Massive stars at the end of their lives explode as supernovae. The supernova rate in Milky Way is expected to be one in thirty years. Owing to interstellar opacity, they are likely to be visible in optical only if they happen within a few kilo parsec distance. In radio, they can be detected up to the end of the galaxy even with a modest sized telescope. To enable this we are building a dedicated radio Supernova Search Engine (SnSE).

SnSE is envisaged as a transit survey instrument that will scan the galactic plane daily at 11 GHz to detect radio continuum transients. A 1.2 m off-axis paraboloid dish fitted with a commercial Low Noise Block Converter(LNBC) and a contimuum back-end receiver form the hardware part of the system (Fig. 1a). Its software part includes data acquisition, analysis and declination control. Currently a chopper wheel based load switching is employed to calibrate system gain variations. In future, we will use a recently proposed phase switching scheme, viz., One Element Interferometry [1], which makes single dish continuum measurements robust.

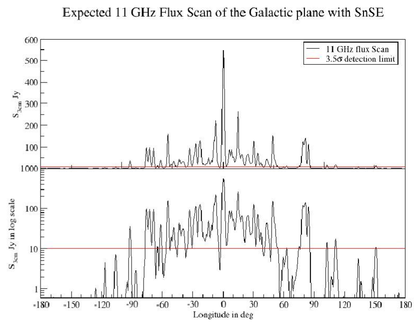
The peak luminosity of a typical radio Supernova is $2 \times 10^{27} erg/sec/Hz$. The expected flux density at a distance of 20 kpc will be around 5000 Jy. The one sigma sensitivity of the above system is expected to be around 2 Jy, assuming a system temperature of 150 K, a bandwidth of 400 MHz, aperture efficiency of 0.5 and an integration time of 100 s. Therefore, even the farthest supernova explosion in the Galaxy will be detected at a high SNR so that its light profile can be followed at least for a few days if not weeks.

With the phase switching scheme, we will measure the continuum profile of the Galaxy daily. This emission is mainly composed of thermal Brehmstraalung and synchrotron. An expected continuum profile is obtained using a radio catalogue of galactic HII regions [2]. The flux densities of sources along the Galactic plane are extrapolated to 11 GHz and convolved with Gaussian beam to get an array of observed flux density from -180^o to +180^o longitude in steps of 0.5^o. The plot of the expected continuum profile along with 3.5 σ detection limit is shown in Fig. 1b.

Current measurements set 190 K as the upper limit for the system temperature. We are in the process of estimating (1) more accurate system temperature and flux sensitivity, (2) beam size from a drift scan of Sun, (3) receiver stability time using Allan-variance analysis. In this paper we will present the overall system, its performance analysis and the first light measurements.



(a)



(b)

Figure 1. (a) the block diagram of SnSE (b) Expected continuum profile along with 3.5 σ detection level

References

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[2] R. Paladini *et al.*, "A radio catalog of Galactic HII regions for applications from decimeter to millimeter wavelengths", *A&A*, **397**, January 2003, pp. 213–226, doi:10.1051/0004-6361:20021466.