A K BAND SEARCH FOR STARBURST SUPERNOVAE

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Abstract. We are conducting a search for supernovae in starburst galaxies at the IRTF. The major difficulty is to reliably detect weak point sources in the presence of a bright and structured background. Our technique is to apply various spatial filters to images taken at different epochs and construct catalogs of objects. We find that comparing catalogs is a robust means of detecting transient sources. Our sensitivity is approximately K=17 outside the inner arcsecond of IRAS BGS galaxies.

Key words: starburst galaxies supernovae k band imaging

1. Supernovae in Starbursts

In a young stellar population one expects a supernova rate of

$$r_{SN} \approx \frac{L_{Bol}}{2 \times 10^{11} L_{\odot}} \mathrm{yr}^{-1},$$

thus typical starburst galaxies with far infrared fluxes in the range $1 \times 10^{10} - 2 \times 10^{12} L_{\odot}$ should have between .05 and 10 supernovae per year.

In a starburst, the bulk of the emission comes from a region with $A_v > 10$ magnitudes, preventing detection of supernovae in the optical. Luckily the photon spectrum of supernovae within a month of maximum is nearly flat from v to K, so using a photon counting detector at 2 microns is a nearly optimal strategy. Type II supernovae reach a maximum K band luminosity of $M_K = -19$, which is magnitude 17 when placed at 50 Mpc with 2.5 magnitudes of extinction. Our search is targeted for supernovae falling above this limit.

2. Search Strategy

We have chosen our target list from the IRAS Bright Galaxy Sample, subject to the following constraints: $r_{SN} < 2\ \mathrm{yr}^{-1}$ to avoid supernova confusion; given the mean surface brightness within 5" of the nucleus, a supernova must be detected with sufficient contrast using the typical IRTF beam; 2 nights of observing time are available each run; the anticipated observing time to detect a supernova is minimized. Our observing strategy is to image available galaxies from our list 2 or three times each semester at the IRTF, being careful to monitor the point spread function. We build up a point source image by using a sky position containing the nearest real GSC star

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with $V < 13$ (some GSC "stars" are galaxies). At the telescope we do an initial quid look of the data, which we estimate is sensitive to supernova brighter than $K = 16$. Typical on source integration times are 5-15 minutes.

3. Data **Processing**

We have experimented with numerous techniques for picking point sources out of galaxy images. The strong background from the galaxy's extended emission and steep central gradient complicate the problem. So far we have found good results with this method:

We use the simultaneously measured point spread function to perform a Richardson-Lucy deconvolution of the galaxy image. Usually five or so iterations are optimum. To monitor the progress we throw in a bright point source on top of the galaxy (but not on its center) and require that no moats develop.

If the galaxy possesses substantial symmetry, we fit a model of nested ellipses to the deconvolved image in order to estimate the smooth galaxy light,. This model is then subtracted from the deconvolved image, leaving the excess light over the mode].

The IRAF task daofind is used to pick out potential point sources in the filtered image.

We compare the lists of extracted point sources from different epochs, looking for significant changes. While an unextincted supernova will pop right out at us, a few magnitudes of extinction will immediately push a supernova into our sensitivity limit.

So far we have not detected any new supernovae, but a number of point-like image artifacts have been found which we think are low level cosmic ray hits. We expect substantial near term improvements in the experiment as the NSFCAM comes into use at the IRTF. Eventually K-band interferometers with 10-100 meter baselines will routinely discover supernovae at large redshifts. We are interested in obtaining misting FITS images of any starburst galaxy (email: dave@ipac.caltech.edu).

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