Deep ISOPHOT Observations of the Supernova Remnant MSH 11-54

by

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with support from the

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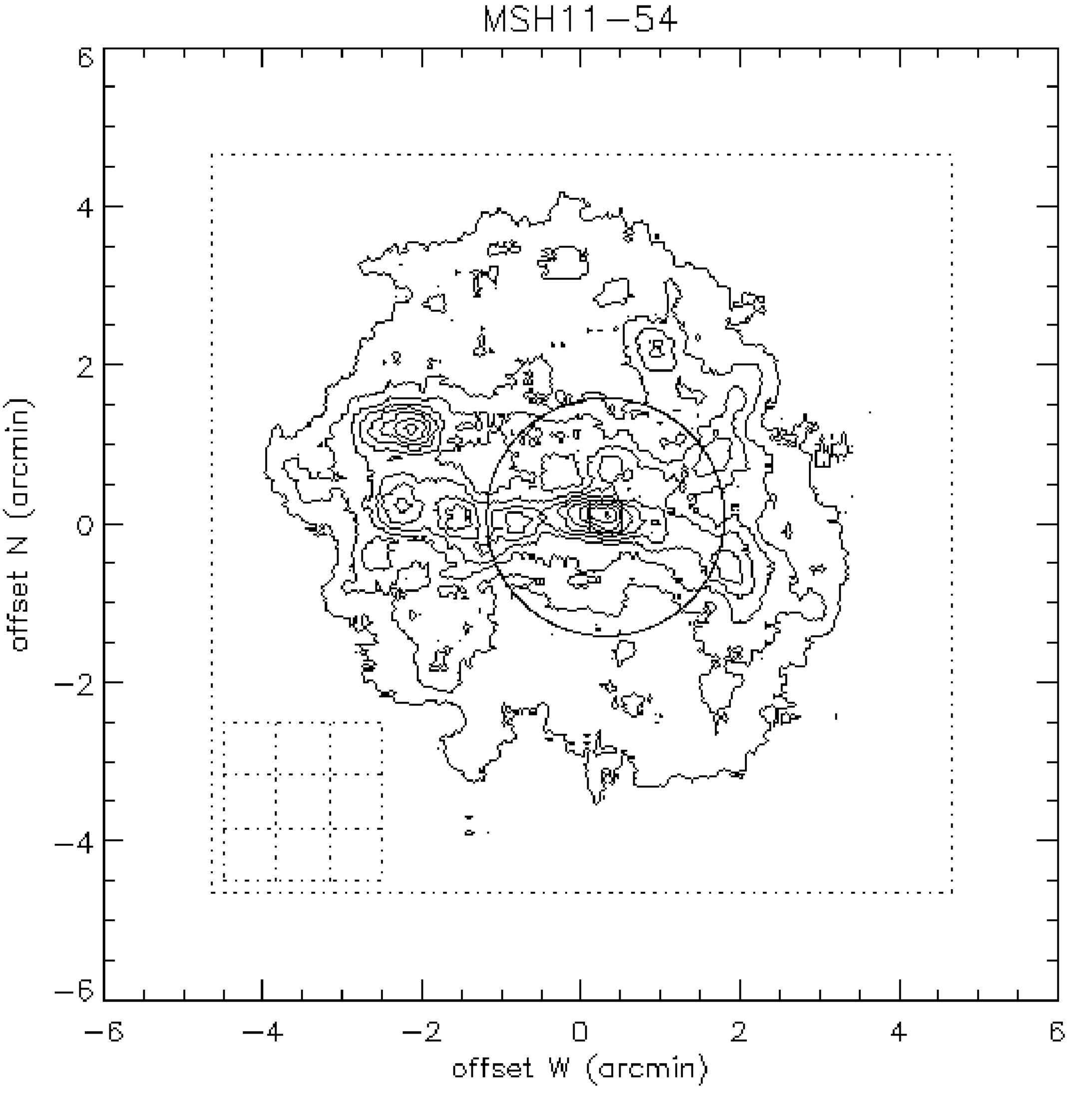
MSH 11-54 (G 292.0+1.8)

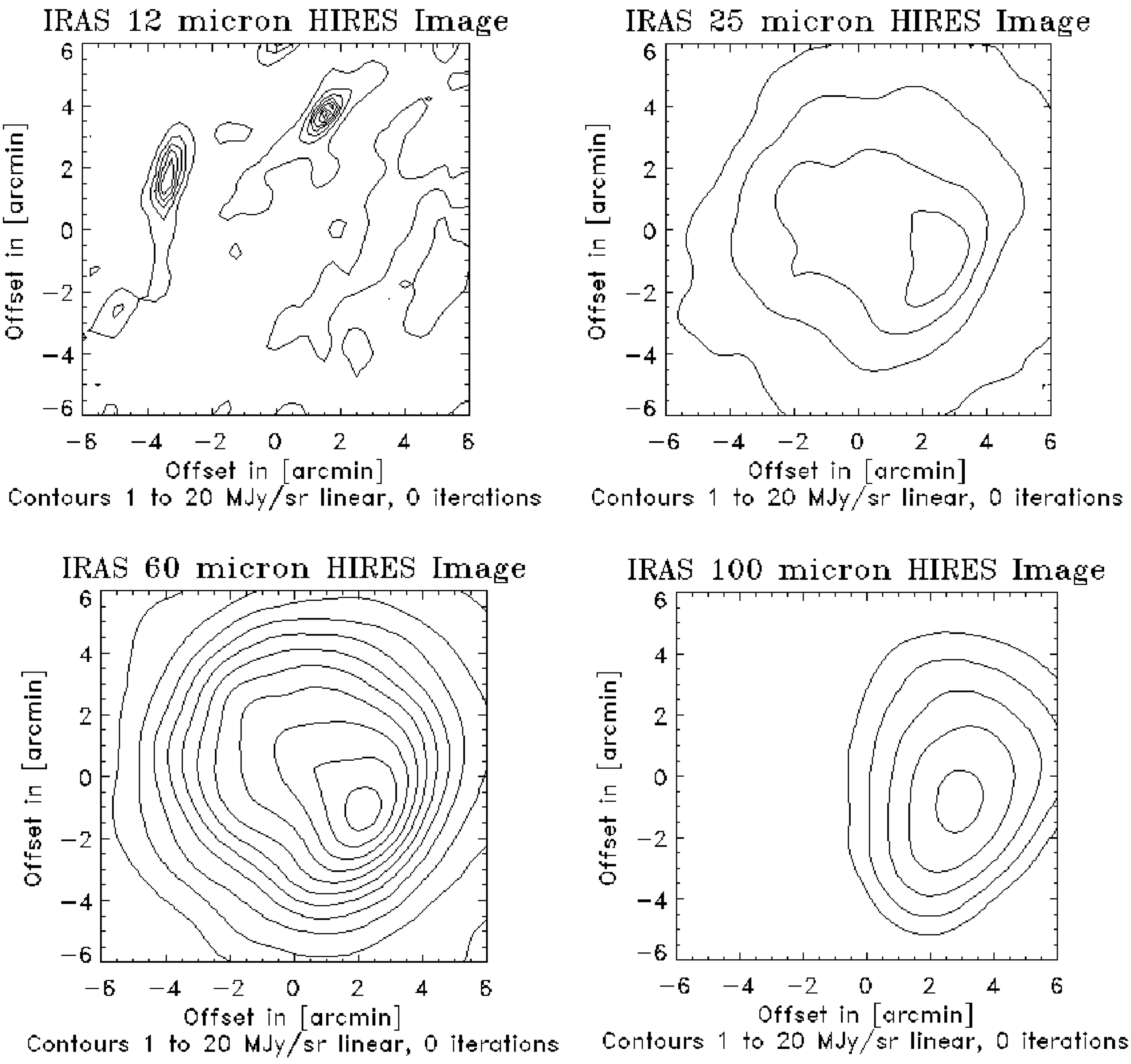
- Oxygen rich, Type II Supernova remnant
- Distance: 3.6+/-1.5kpc, estimated from IRAS line of sight dust content
- Even took place in historic age: 1100+/-460yrs / 1750+/-250yrs calculated from radio and X-ray expansion models
- Angular Radius: ~2 to 4 arcmin
- Absolute Radius: 5 to 10pc
- Optical spectra show clumps of oxygen rich ejecta as in Cassiopeia-A, with evidence for Neon, but not for Sulphur.
- X-ray and optical spectroscopy are consistent with a progenitor star with initial mass of 20 to 25 solar masses.
- The remnant shows a peculiar X-ray morphology (non-symetric bi-polar expansion?)

MSH 11-54
Einstein HRI (0.5 - 2 KeV) Image

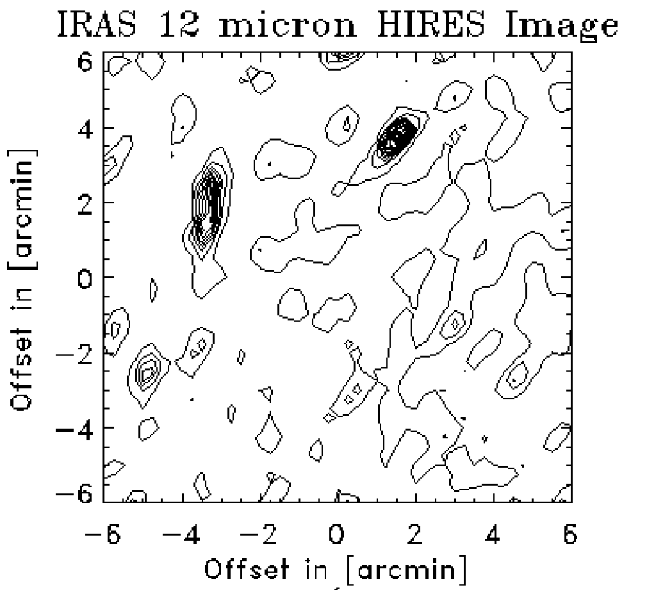


0.5-2KeV brightness distribution of MSH 11-54 (Einstein HRI) convolved with the 24x24” PHT-S entrance aperture. The outline of this aperture is overdrawn at the position of the PHT-S pointing towards the peak of the X-ray emission. The frame shows the size of the PHT-C P32 map. The size of the PHT-C array is show in the lower left-hand corner. The circle indicates the position and aperture size of the 180” PHT-P wide-beam photometry.

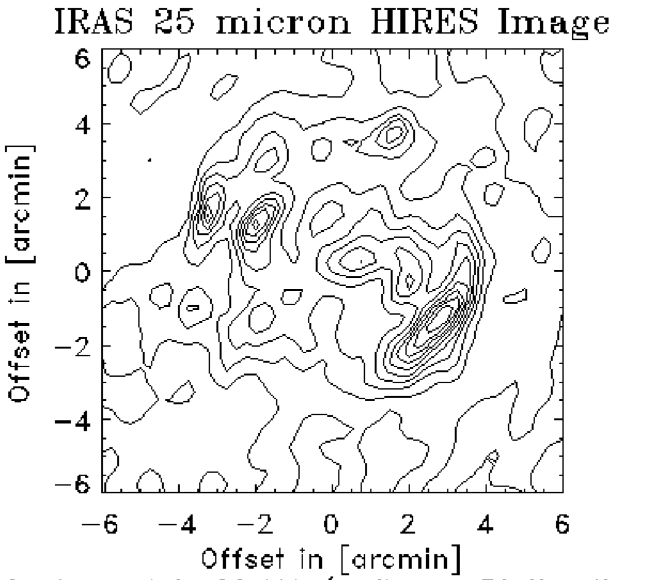
MSH 11-54 IRAS HIRES Maps
(Input Data)



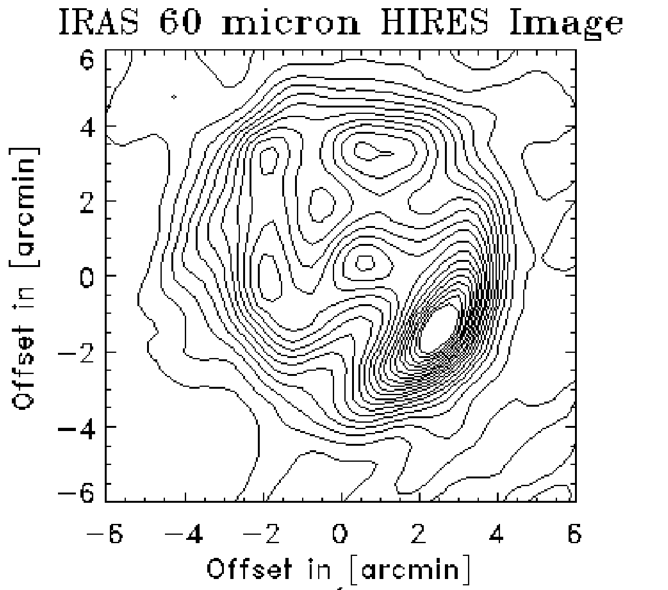
MSH 11-54 IRAS HIRES Maps
(50 Iterations)



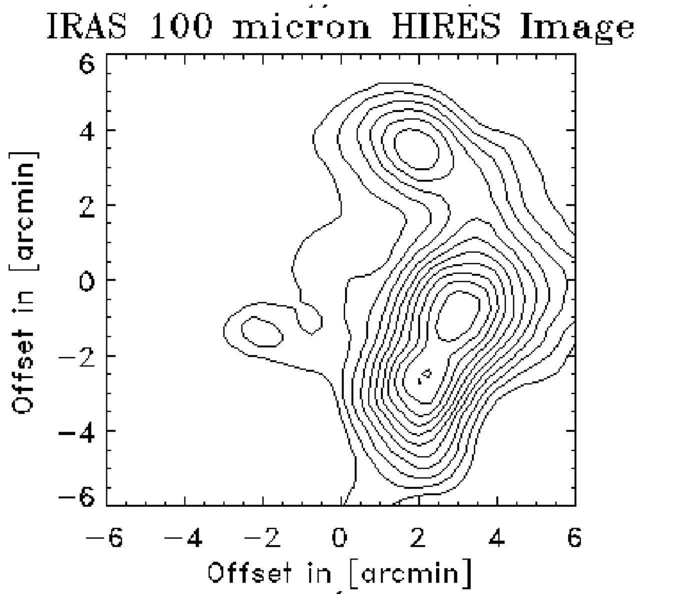
Contours 1 to 20 MJy/sr linear, 50 iterations



Contours 1 to 20 MJy/sr linear, 50 iterations

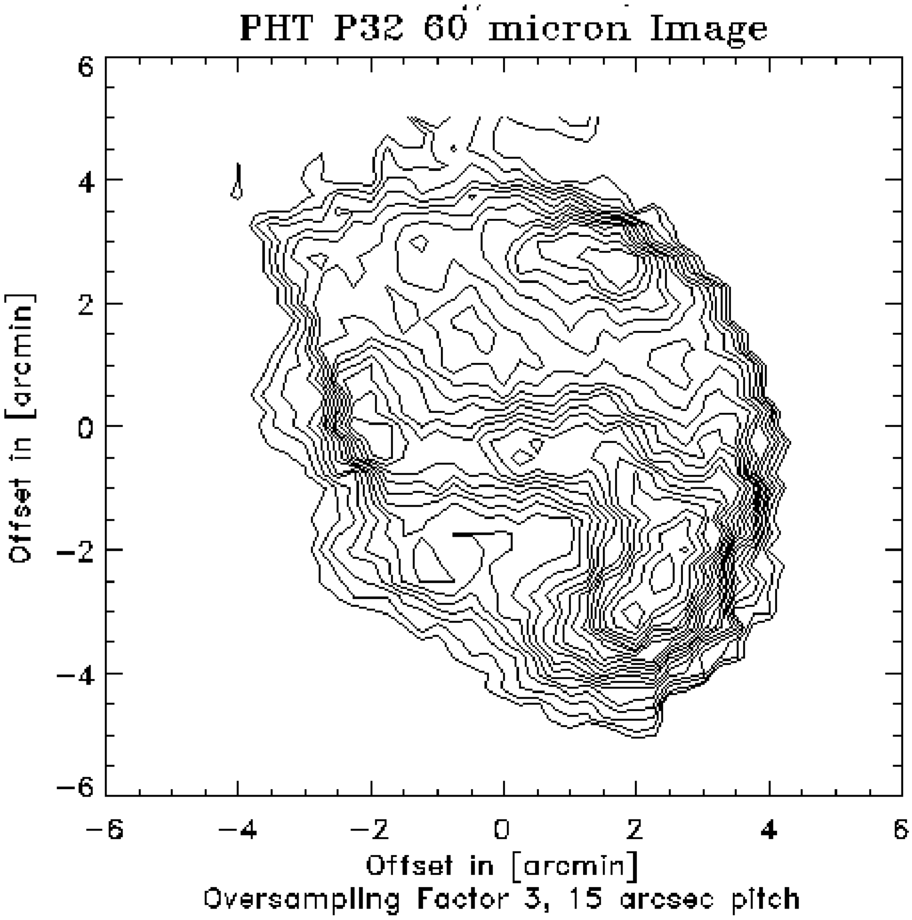


Contours 1 to 20 MJy/sr linear, 50 iterations

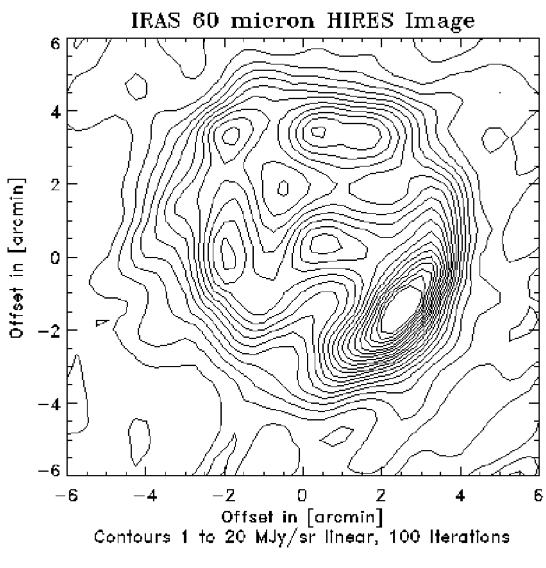


Contours 1 to 20 MJy/sr linear, 50 iterations

MSH 11-54 ISOPHOT-C Map



ISOPHOT-C P32 map of MSH 11-54 at 60µm with oversampling factor 3, i.e. 15” pitch. A background of 55MJy/sr was subtracted. The contour lines are linear 1...20 MJy/sr. For comparison on the left, the IRAS HIRAS image in band 3 after 100 iterations, same absolute scale. In the lower left the SNR interacts with a denser ISM region towards the direction of the galactic plane.



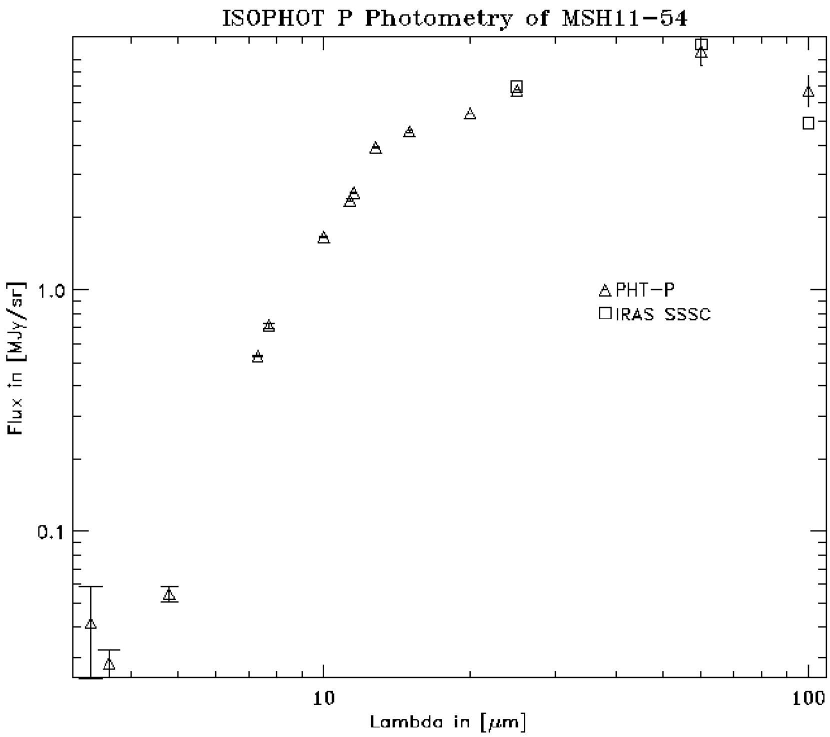
MSH 11-54 ISOPHOT-P
3-100µm Widebeam Photometry

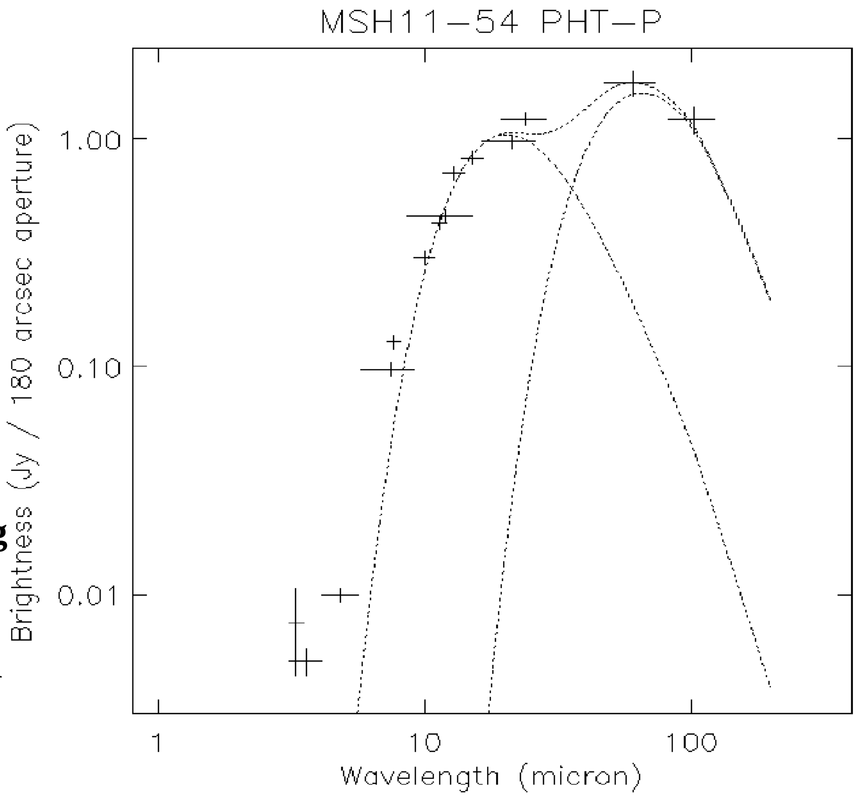
PHT-P 180" photometry compared to IRAS Small Scale Structure catalogue, scaled to the size of the remnant, assuming a filling factor of 0.6. The error bars show the pure statistical 1σ uncertainties, proving the high stability of the P1 detector. The absolute calibration is still somewhat uncertain due to problems with the FCS data.

The spectrum is smooth from about 3µm to 100µm, compatible with a dust continuum with grain temperatures in the whole range of 50 to 1000K.

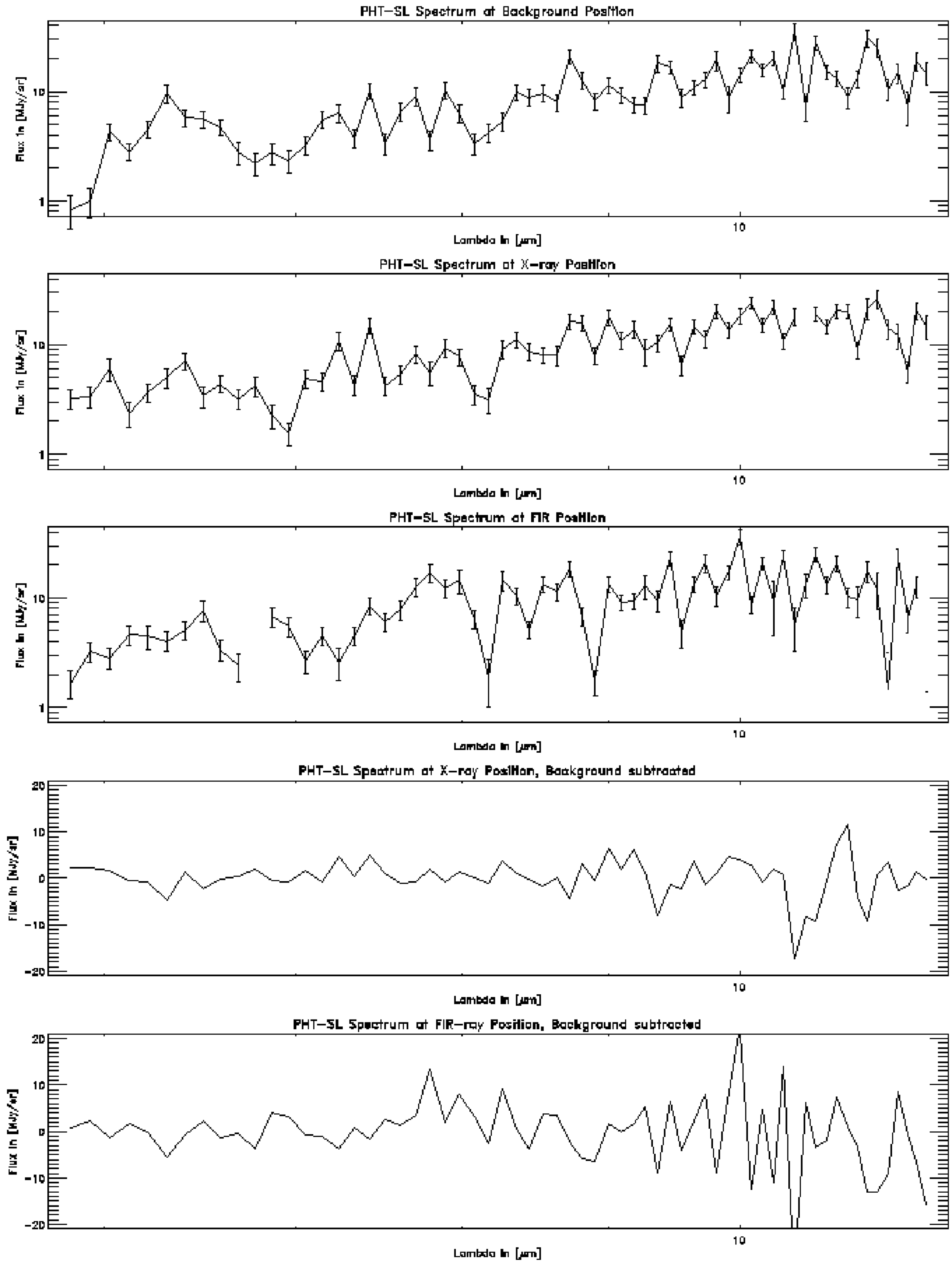
The spectrum shows no indication for the UIRF at 7.7 and 11.3µm, compatible with the destruction of the PAHs in the hot gas of the SNR shell. There is also no indication for the 10µm silicate feature.

The lower plot shows a two component dust model using modified black-bodies of 50K and 160K. It describes the spectral shape quite well down to about 10µm. The excess at 25µm could be a calibration problem.





MSH 11-54 PHT-S Spectrophotometry



PHT-SL 6-12µm Specrtophotometry at a background reference position and two positions in MSH 11-54, the peak of the X-ray and the 60µm FIR emission. No indication for line emission from Ar [II], Ar [III] or S[IV] was found down to the detection limit of about 10MJy/sr.

Cassiopeia A ISOPHOT-S Spectrophotometry

ISOPHOT-SL 6-12µm Spectrophotometry at two positions extracted from a PHT-S map of the Cassiopeia A shell. Above: typical spectrum at a background position outside the remnant; showing a strong PAH 11.3µm feature. Below: A spectrum of Cassiopeia A at the maximum of the FIR emission. The spectrum shows strong, Doppler broadened lines of Ar[II], Ar[III] and S[IV].

Summary and Conclusions

- **Scientific**

– The 60 µm P32 map of MSH 11-54 resolves a central rim across the SNR similar to the X-ray morphology. In addition a bright FIR area is seen towards the direction of the galactic plane, where the SNR interacts with a cloud of denser ISM.

– Wide beam PHT-P photometry of MSH 11-54 shows no indication for PAH features at 7.7 and 11.3µm nor for the 10µm silicate feature, but only a smooth dust-like spectrum. The spectral shape can not adequately be described by a simple one or two component dust model. Detailed modelling of the dust grain size distribution is needed.

– PHT-S spectroscopy of MSH-11-54 shows no indication for Ar [II], Ar [III] or S [IV] down to a detection limit of about 100mJy/beam, i.e. species are a factor of 50-100 less abundant than in Cassiopeia-A

- **Data Analysis and Observational Techniques**

– Comparison of PHT P32 map and IRAS HIRES maps shows very good resemblance both w.r.t. structure and photometry down to the 1MJy/sr level.

– PHT-P wide beam calibration drastically improved by using FCS calibration data as of 27.1.97.

– Ramp splitting improves S/N on observations of faint objects, both for PHT-P and PHT-S.

– PHT-S raster mode observations of Cassiopeia A show the superiority of this observing strategy compared to the long staring observations used to observe MSH 11-54. This is due to redundancy, detector stability and better background determination.