Topic : High resolution Infrared spectrum of SN1987A

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We propose observations of SN 1987A to disentangle and follow the shock evolution of the shock components resulting from the ejecta and circumstellar ring interaction. The high spectral resolution of CRIRES will provide new and unique insight for this object in the IR.

Abstract:

The supernova shock has now reached the equatorial ring and has set off a firework at all wavelengths. This means that we now have a situation in which a forward shock is driven into dense material, a reverse shock has been created and the environment is bathed in an intense radiation field. There are four principal emission sites that can be distinguished: the fluorescent ring (1), the shocked ring material (2), the ejecta going through the reverse shock (2) and the glowing ejecta in the centre (4). The emission from all four sites carries different signatures and CRIRES can contribute to investigate some of the physics that is taking place.

The high spatial and spectral resolution of CRIRES will resolve the quiescent ring emission (1). The velocity width of these lines is about 10 km/s and we have detected many of them in our optical UVES spectroscopy (see Groeningson et al. 2006). We also have UVES time for period 78 and CRIRES would ideally complement this data set. The shocked ring (component 2) has velocities of around 200 km/s and from the UVES data we know that the emission line is asymmetric. In our optical data we have detected about 170 emission lines from this component. CRIRES will provide the IR view of this very special region. Our SINFONI and ISAAC data do not resolve either (1) or (2) and CRIRES will provide a unique insight. Finally, the ejecta in the centre (4) and the reverse shock (3) have velocities above 3000 km/s and therefore not appropiate for CRIRES.

In our SINFONI spectrum we have several unresolved lines (from components 1 or 2), for which the identification is uncertain or unknown. CRIRES will separate the two emission sites, based on its higher resolution. We would concentrate on some specific lines (He I 1.084, 2.06, Pa beta and gamma, and [Fe II] 1.25)

Target List and Table

name	lambda range	wavelength ID	Fline 10-16erg/s/cm2	exp. time DIT, NDIT	slit=0.4" S/N 2nm	0.04nm
SN1987A He I	1081.-1086.nm	52/0/i		900s, 8	1	39
SN1987A He I	2051.-2062.nm	27/-1/n	108	900s, 8	3.4	96
SN1987A P_beta	1282.-1288.nm	44/0/n	320	900s, 8	4	102
SN1987A P_gamm	1092.-1097.nm	51/0/n		900s, 8	3	93
SN1987A [FeII]	1249.-1255.nm	45/0/i	70	900s, 8	0.8	31

Since we want to resolve the narrow component we need a slit width of 0.4". The somewhat long exposure times are because we want to get both the intermediate component (width 2nm) and the narrow component (width 0.04 nm).
In calculating the exposure time we have used a seeing of 0.8", and an airmass of 1.4. We are assuming the observations are in the end of October where the target is higher in the sky.

We have the fluxes for the [Fe II] , He I 2058nm, and P_beta lines from previous observations. We have in the calculations assumed that the helium lines has the same flux and the hydrogen lines has the same level line has the same flux. We are also assuming that half of the flux is in the narrow component (width 0.04 nm) and the other half is in the intermediate component (width 2nm). For the iron line the width observed with SINFONI was 0.6 nm, that yields a S/N of 5 for a slit of 0.4".

Target: SN 1987A 05:35:28.102 -69:16:10.94

Slit:
Slit Either 0.8 or 0.4 arcseconds.
The position angle should be 30 degrees (see finding chart)
The target is 1-2 arcseconds across.

Adaptive Optics notes:
The AO guide star is 'Star 2': 05:35:27.74 -69:16:08.8
Facts: B star located 3 arcsec north-west from SN1987A. R=15.01 and B-R=-0.32

Reference Star for blind offset:
'Star 3' (see finding chart): 05:35:28.377 -69:16:11.73
offset from Star 3 to SN 1987A is: 1.47" West and 0.80" North

Comments: The positions are from HST and should be accurate to within 0.4".

Detailed description of suggested observations:

The purpose of the observations are to separate the intermediate component (~200 km/s) from the narrow component (~10 km/s). For that we need the high resolution that CRIRES can provide with the 0.4" slit. This forces us to have somewhat long integration times so that the S/N will be high enough for the intermediate component.

We find the helium lines very important. The He I 1083 nm line is sensitive to the temperature and density, and the He I 2058 nm is mainly set by recombination.

Also the Hydrogen lines are necessary for determining the He/H ration. The P_gamma is interesting to observe because it falls outside of the SINFONI wavelength area.

A majority of the emission lines from SN 1987A are iron lines. We have chosen to observe only one iron line, this line was not resolved by SINFONI and we would like to determine the true broadening of it.

Since we have already only chosen the most important emission lines from this object it is difficult to put a priority on them. But a simple minimum would be the iron line, the two helium lines and the P_gamma line.

SCIENCE GOALS:

These SV observations are part of an extensive study of SN 1987A in the IR with the VLT. The observations are supported by data at many other wavelengths investigated by us or our collaborators. Since this is an evolving target the observations will be of high value and give unique information about the SN in its metamorphosis into a SNR.

K. Kjaer is in her final year of her PhD and she is familiar with both SV observations and infrared. She will be reducing the data using the support of the co PIs and the scientific staff at ESO.