Doppler Velocities of X-ray Knots and Filaments in the LMC SNR N132D

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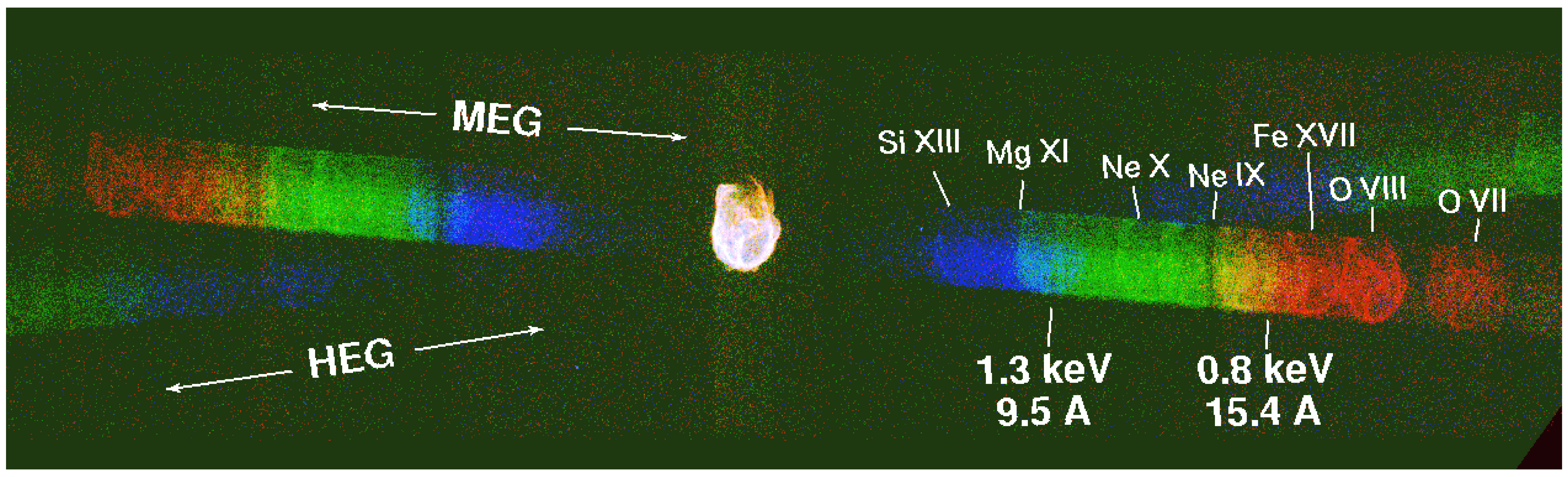
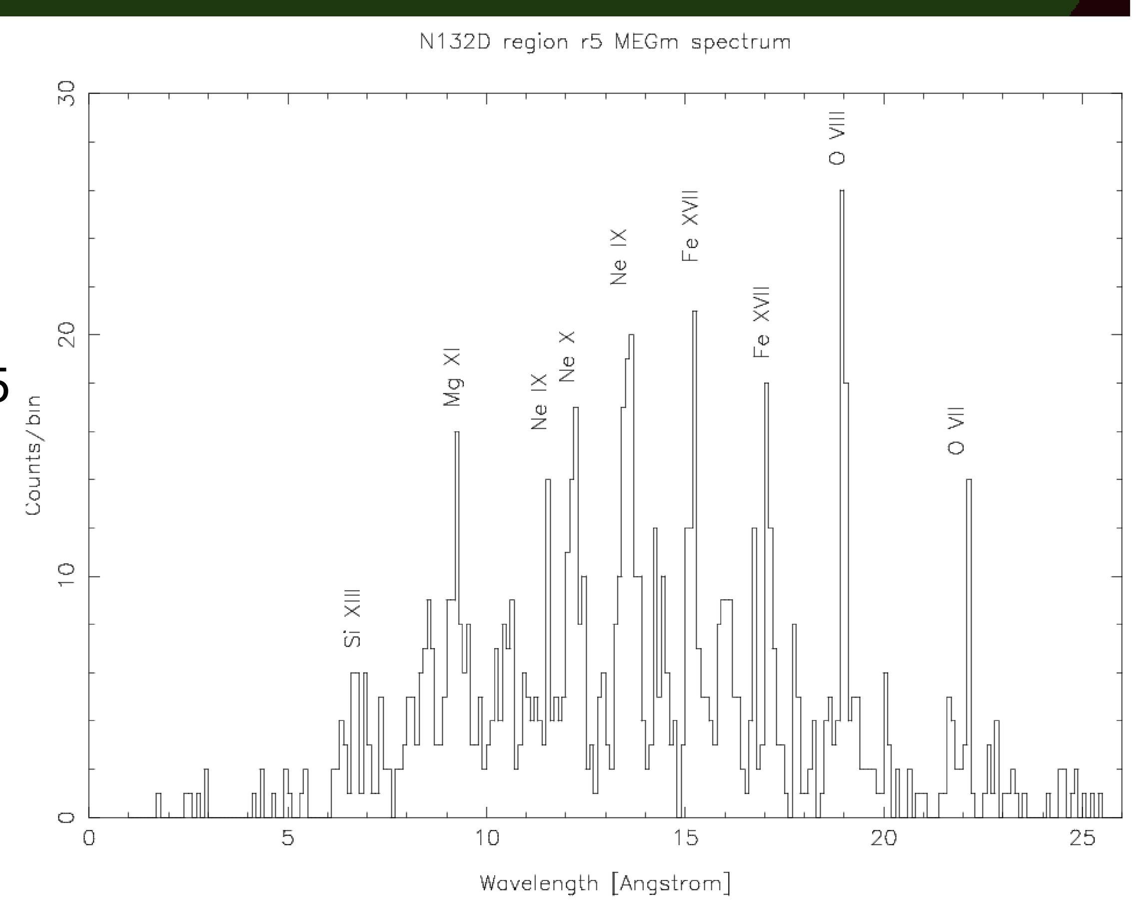
Dispersed Spectra: What's in this Supernova Remnant?



Above: Dispersed image showing the plus and minus orders of the High Energy and Medium Energy Gratings (HEG, MEG). Major emission lines are labeled.



Right: MEG(-1 order) spectrum of region r5 with major emission lines labeled.

The X-ray spectrum contains prodigious emission from oxygen, neon, magnesium, iron and some silicon (Canizares et al. 2001, Behar et al. 2001).

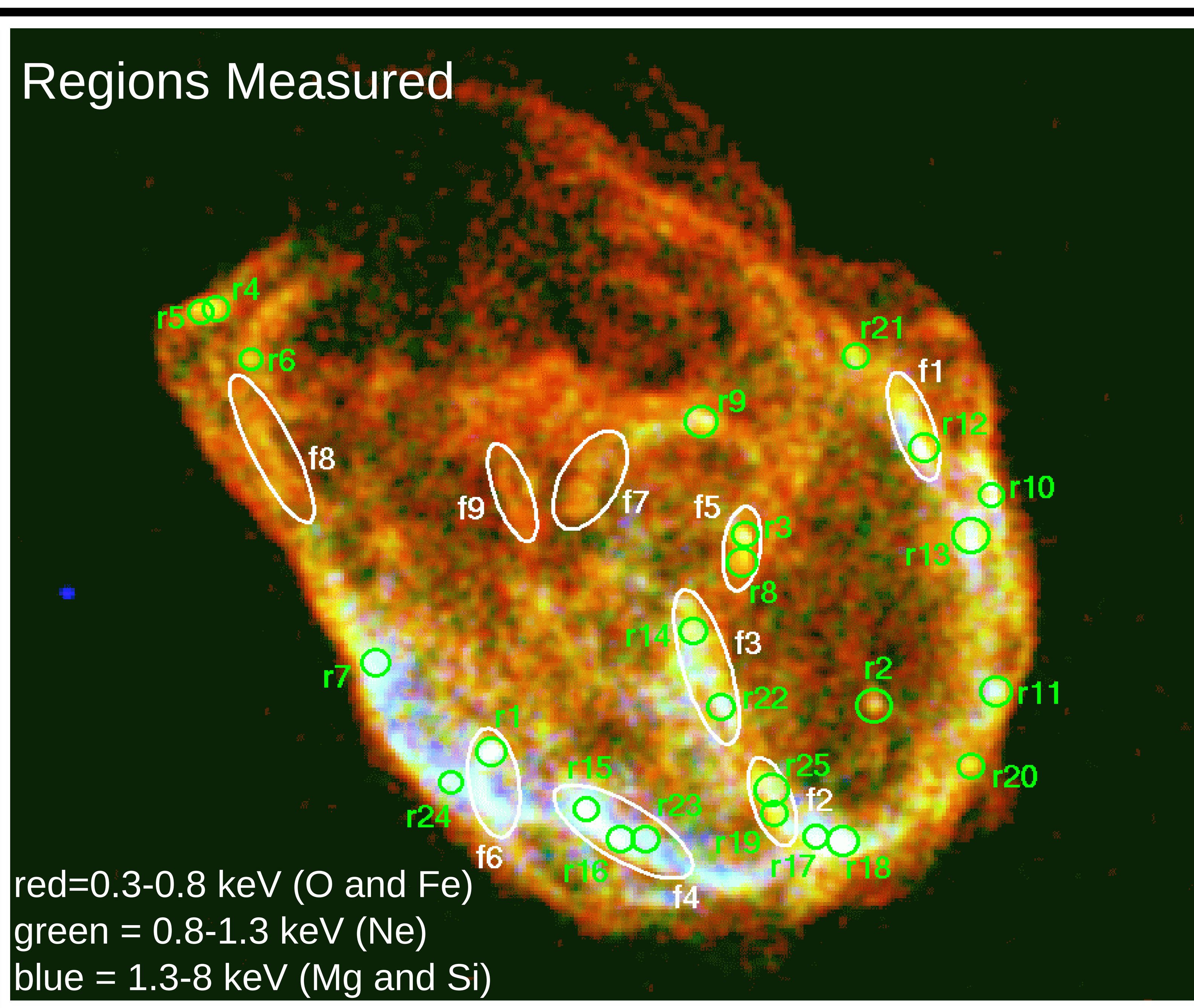
ABSTRACT

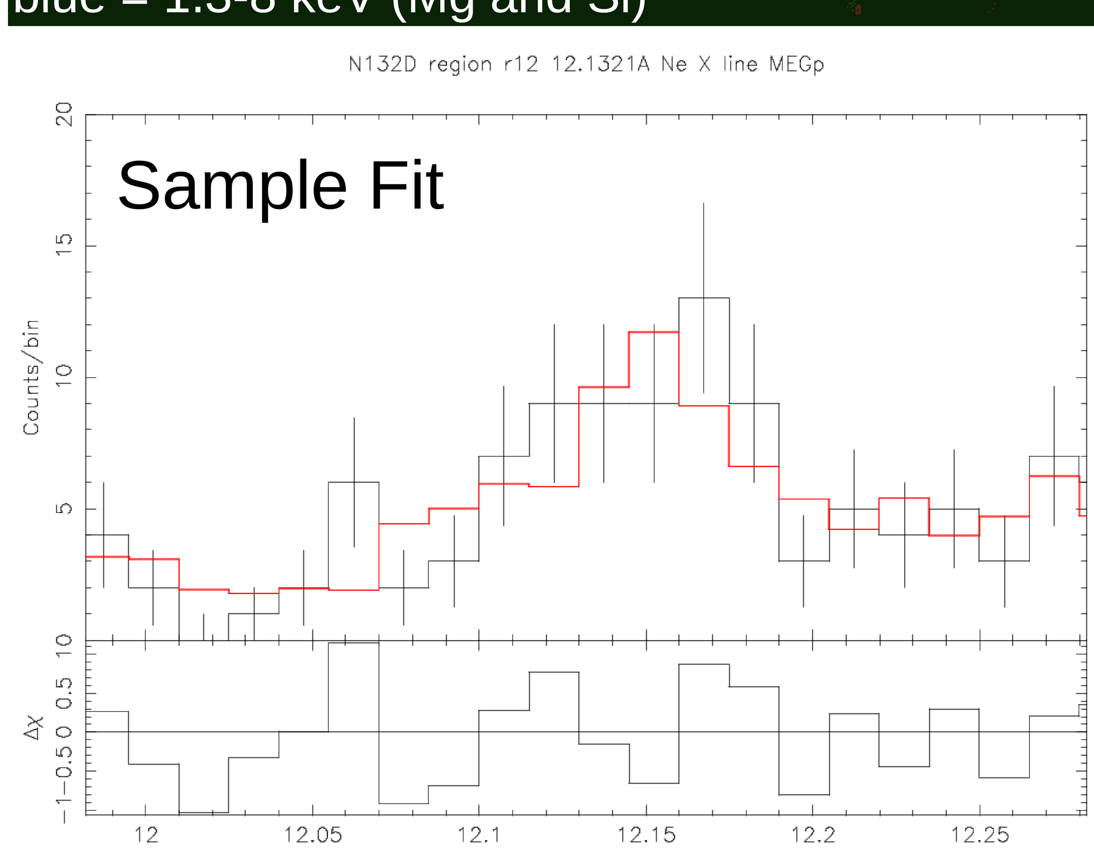
The oxygen-rich supernova remnant N132D in the Large Magellanic Cloud was observed with the High Energy Transmission Grating Spectrometer onboard the Chandra X-ray Observatory. Individual emission lines of oxygen, neon, magnesium, silicon, and iron are observed and Doppler shifts have been measured. We find Doppler velocities of knots and filaments of only a few hundred km/s supporting previous abundance studies that concluded that the X-ray emission is mostly swept-up ISM and not ejecta.

N132D PERSONAL INFORMATION

- Oxygen Rich
- Type Ib SN (Blair et al. 2000)
- 3000 yrs old (Morse et al. 1995)
- X-ray abundances typical of LMC – swept-up ISM rather than ejecta (Hwang et al. 1993, Favata et al. 1997, Hughes et al. 1998)
- Optical/UV abundances also support ISM hypothesis (Blair et al. 2000)
- Optical Doppler velocities show mostly slow-moving ISM flocculi but there are some fast-moving ejecta knots near the center

region	velocity (km/s)	error (km/s)
r1	76	357
r2	-87	718
r3	198	653
r4	171	310
r5	-132	337
r6	-35	2105
r7	458	334
r8	-35	290
r9	-760	494
r10	217	342
r11	31	1131
r12	15	286
r13	384	532
r14	400	745
r15	346	399
r16	211	246
r17	-317	294
r18	469	670
r19	-108	143
r20	-47	312
r21	394	410
r22	244	247
r23	2	361
r24	-101	612
r25	8	532
f1	62	202
f2	-16	242
f3	361	220
f4	-70	154
f5	133	258
f6	-171	185
f7	-9	516
f8	534	222
f9	-143	386





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MEASURING DOPPLER VELOCITIES

Motivation for this project: Doppler velocities of ISM material can tell us about interactions with the environment while Doppler velocities of the ejecta can tell us about the 3-dimensional structure of the remnant.

Sample of knots and filaments: We selected a range of bright and/or isolated knots and filaments with a range of abundances as shown at left. Knots are identified in green with “r” numbers and filaments are identified in white with “f” numbers.

Which line to fit?: Currently we are fitting the 12.1321 A Ne X line because it is relatively bright, is relatively far from contaminating iron lines, and does not fall across any chip gaps. We will expand to other lines in the future.

How was the fitting done?: For the knots, MEG spectra were extracted over the region shown and were fitted with a Gaussian + line (offset and slope) using ISIS (Houck 2002). The filament analysis basically involves a “straightening” of the extended features as described in Lazendic et al. 2007. By straightening the filaments, we can improve signal-to-noise and still resolve narrow emission lines. The resulting filament spectra were then fitted the same as the knot spectra. An example spectral fit is shown at left.

The Results: Shown in table to left. Sure enough, most velocities are less than +/- 1000 km/s agreeing with optical velocities and indicative of slow-moving shocked ISM.

What's Next?

We need to measure more lines, specifically looking for Fe-bright regions that might be ejecta (Behar et al. 2001). This should help us understand what degree of Fe contamination might exist in our other lines.

Many of these regions were measured in optical emission, let's compare notes.

Line diagnostics!

How do the shocked ISM seen here compare to similar structures in other SNRs such as Cas A and Kepler?