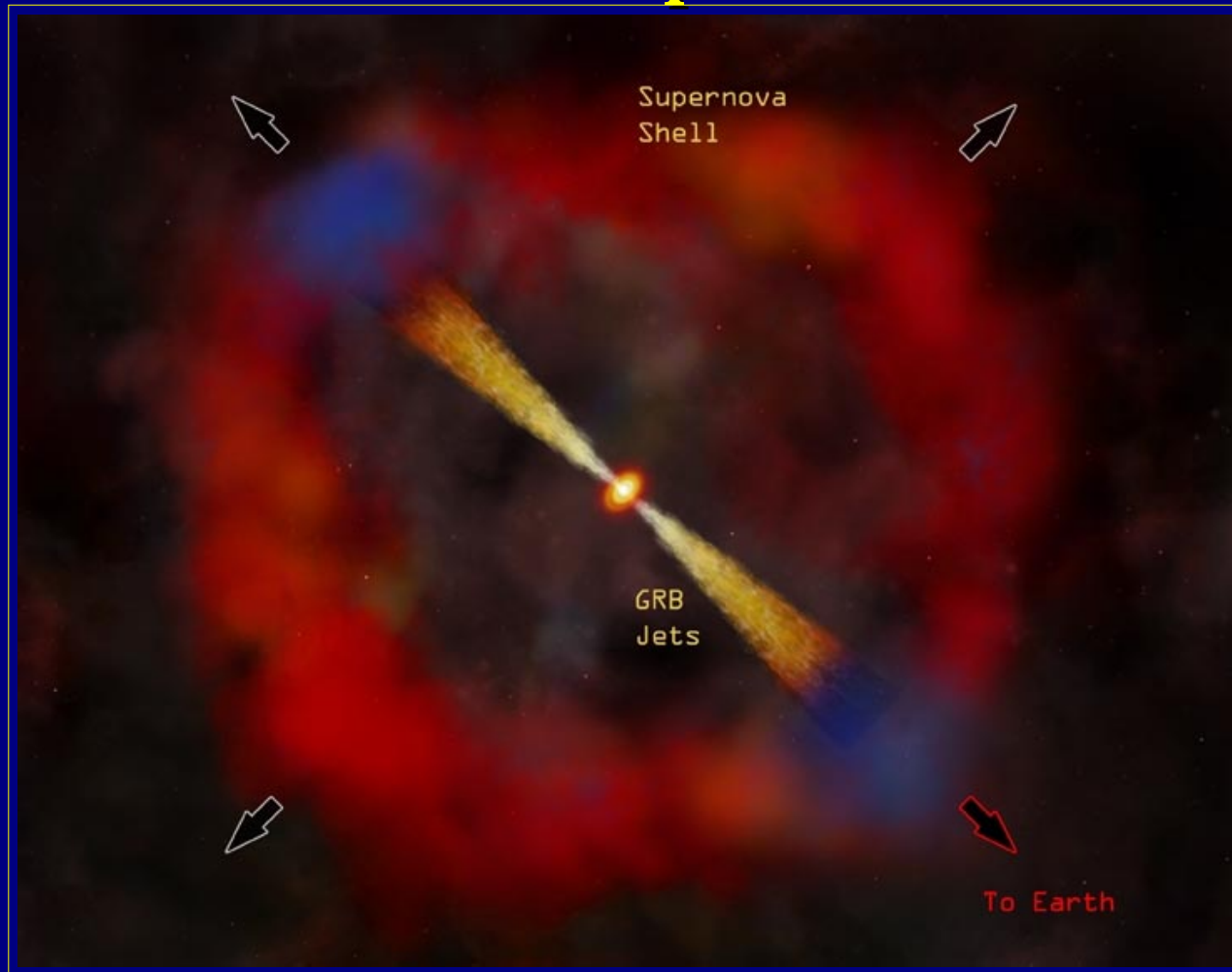


# GRB 020813 with Chandra: Evidence for a Recent Supernova



# Summary of X-ray Lines in GRB Afterglows

## Iron Lines

GRB 970508 (Beppo-Sax)

GRB 000214 (Beppo-Sax)

GRB 970828 (ASCA)

GRB 991216 (Chandra)

## Light Metal Lines

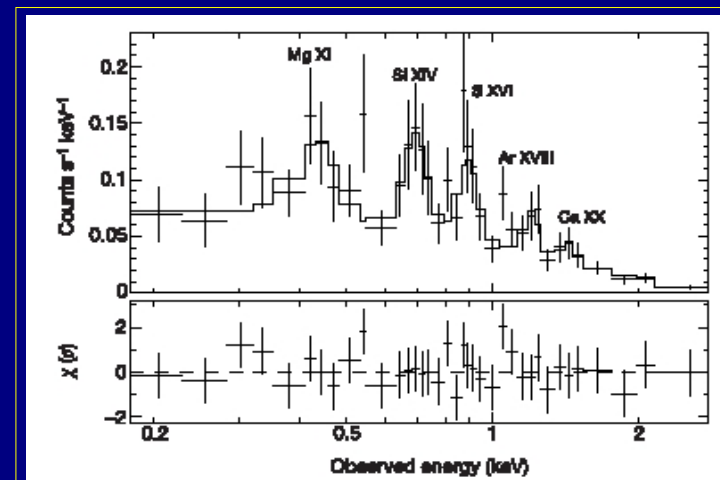
(e.g. Mg, Si, S, Ar, Ca)

GRB 011211 (XMM)

GRB 001025A (XMM)

GRB 020813 (Chandra)

*GRB 011211, Reeves et al. 2002*



# A Long-Duration GRB Discovered by HETE

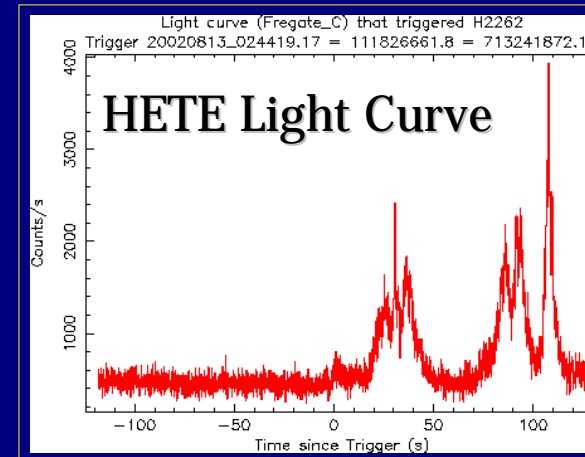
Optical Counterpart Detected  
Rapidly ( $t_{\text{GRB}} + 2\text{hrs}$ ).

Host galaxy is 8.6 billion ly away.

Chandra Observation begins early  
( $\sim t_{\text{GRB}} + 1\text{ day}$ ) and lasts  $\sim 1\text{ day}$ .

Spectrum contains:  $9 \times$  more counts than GRB 991216  
 $5 \times$  more counts than GRB 011211

+ high resolution  $\rightarrow$  best line detection to date!

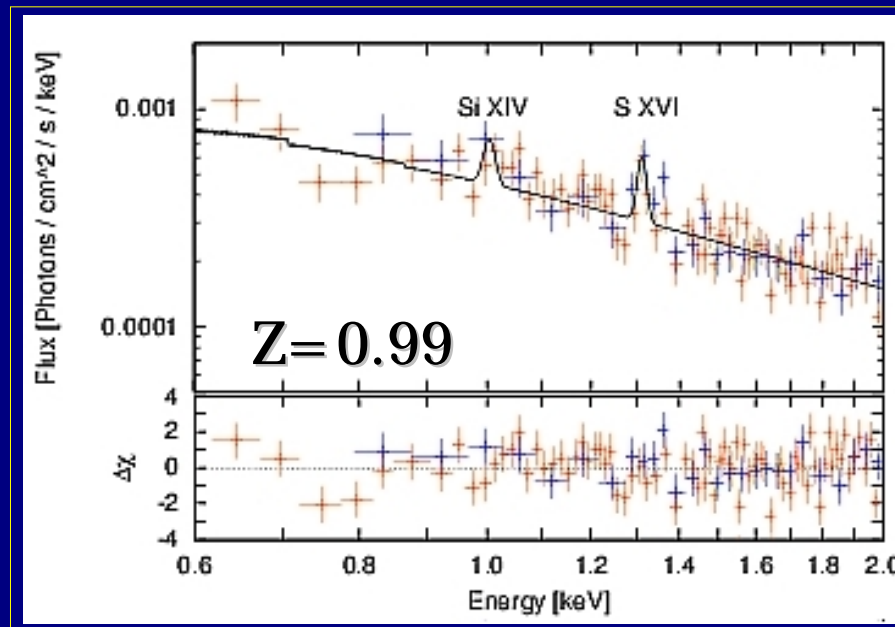


# Two Strong Spectral Lines

Light metals like silicon (Si) and sulfur (S) are characteristically produced during pre-supernova (SN) nucleosynthesis in massive (typically  $\geq 10 M_{\odot}$ ) stars.

The lines we measure are blue-shifted by  $0.1c$ , indicating that they arise from material which is rapidly approaching us. → SN shell!

The lines are narrow and long-lived, indicating that the GRB was beamed into a narrow cone and that the GRB likely occurred  $\sim 2$  months after the SN.



# The GRB Lights-Up a SN Shell

