Studying the radiative recombination continua in the X-ray spectra of pure ejecta plasma

E. Greco[1,2,3], J. Vink[3,4], M. Miceli[1,2], V. Domcek[3,4], P. Zhou[3,5], S. Orlando[2], G.Peres[1,2], F. Bocchino[2]

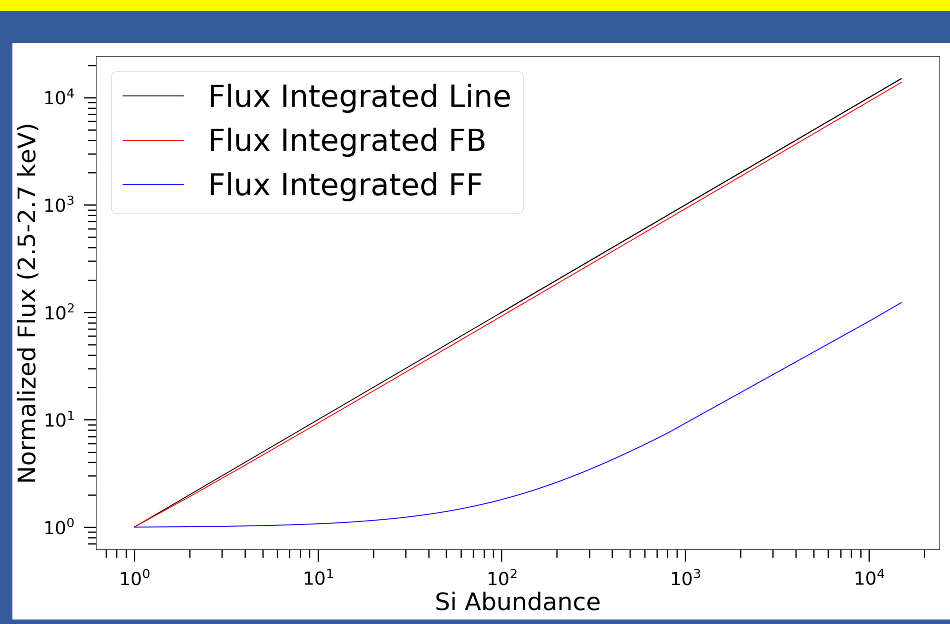
[1]Università di Palermo, Dip. Di Fisica e Chimica,; [2]INAF-Osservatorio Astronomico di Palermo; [3]Anton Pannekoek Institut, University of Amsterdam; [4]GRAPPA, University of Amsterdam, [5]School of Astronomy and Space Science, Nanjing University

Rationale

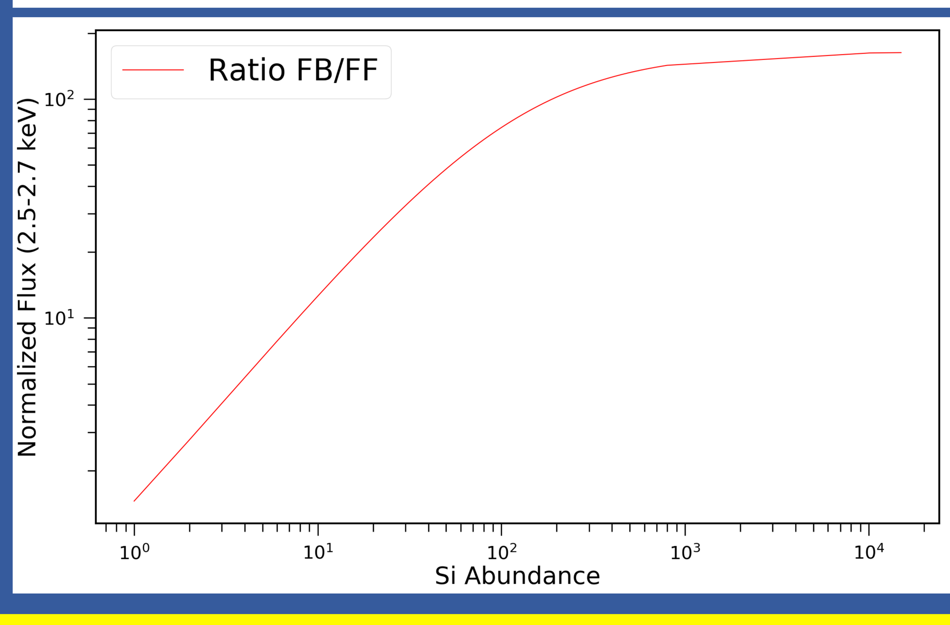
X-ray spectral analysis of ejecta in supernova remnants (SNRs) is hampered by the low spectral resolution of CCD detectors, creating an entanglement between the best-fit values of chemical abundances and emission measure (EM). This degeneracy leads to big uncertainties in the mass estimates. We studied the behaviour of different emission processes (Free-Free, FF; Free-Bound, FB; Line) in high-abundance regimes through a set of spectral simulations to identify a signature of pure ejecta emission in the X-ray spectra of SNRs.

Fluxes vs chemical abundances

Above a given value (ab. ~300 for Si-rich ejecta), the FF flux increases with the abundance, because the number of electrons from Si ionization is higher than that from H ionization.

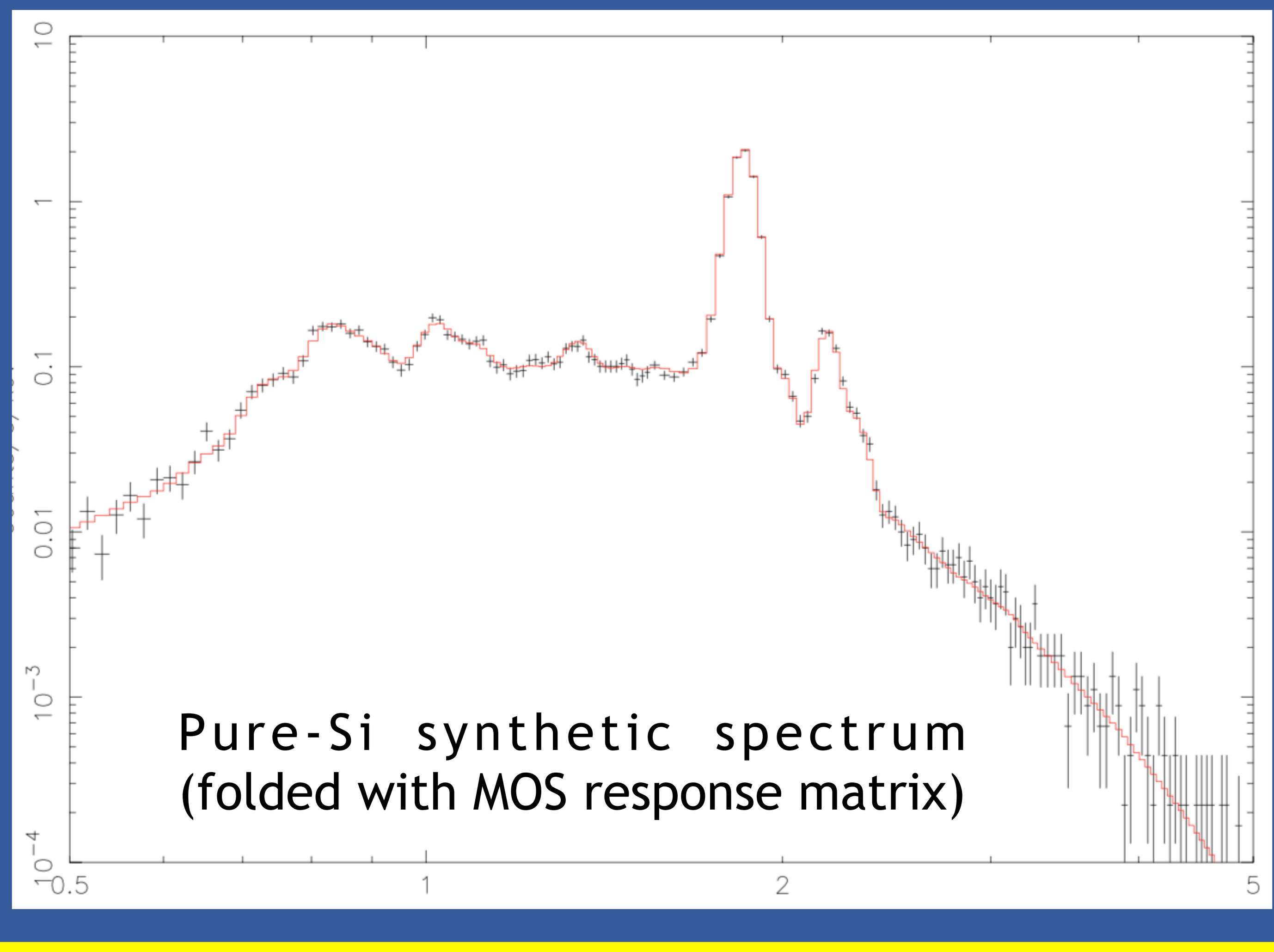


In this regime (pure ejecta), the FB/FF ratio remains constant by increasing the abundance.



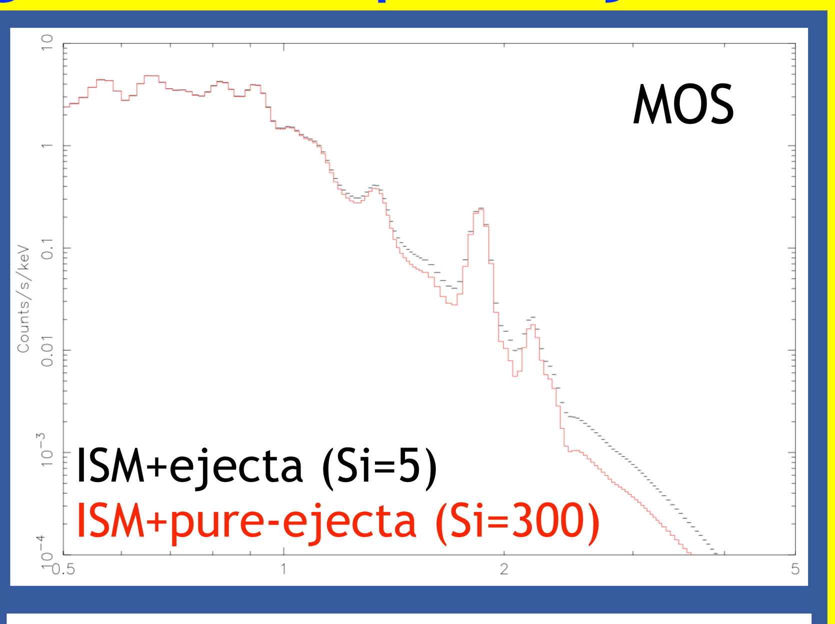
ISM-Pure-Ejecta superimposition

Pure-ejecta emission must be superimposed with that of ISM since no extremely bright lines have been observed so far.

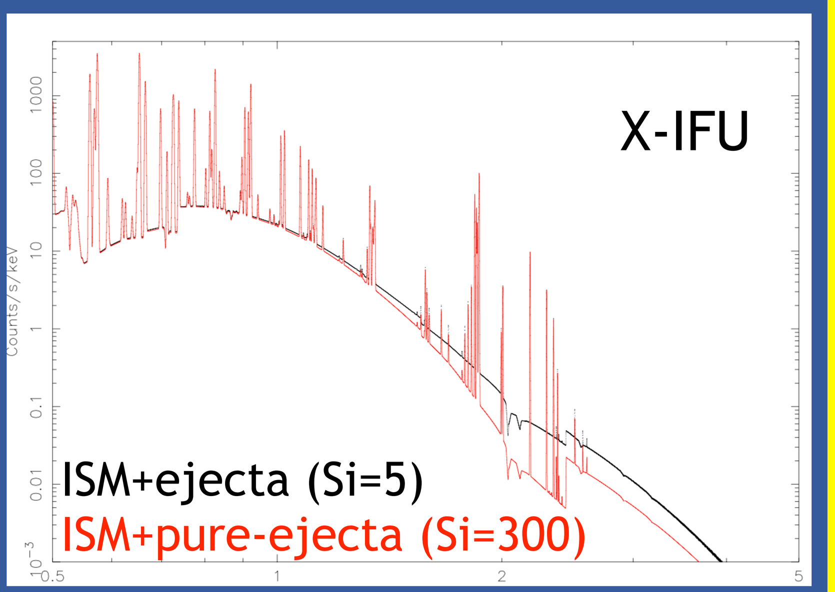


RRC are the spectral signature of pure-ejecta

The poor spectral resolution of CCD detectors do not allow us to discriminate between the pure-metal (Ab.>300) and the metal-rich (Ab.<10) plasmas.

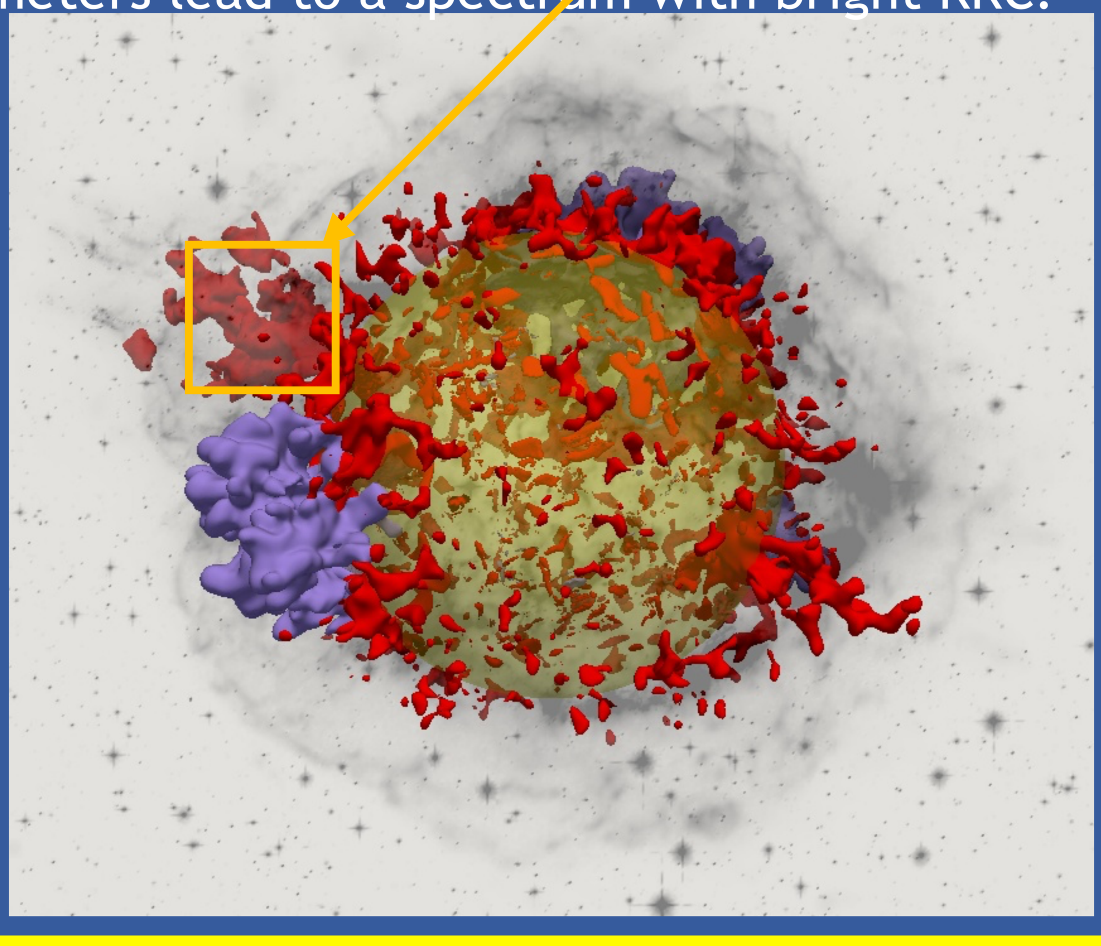


Using microcalorimeters, the He-Si Radiative Recombination Continua (RRC) at ~2.5 keV shows up in the pure ejecta case. This **RRC is a spectral signature** of the presence of pure-Si plasma.



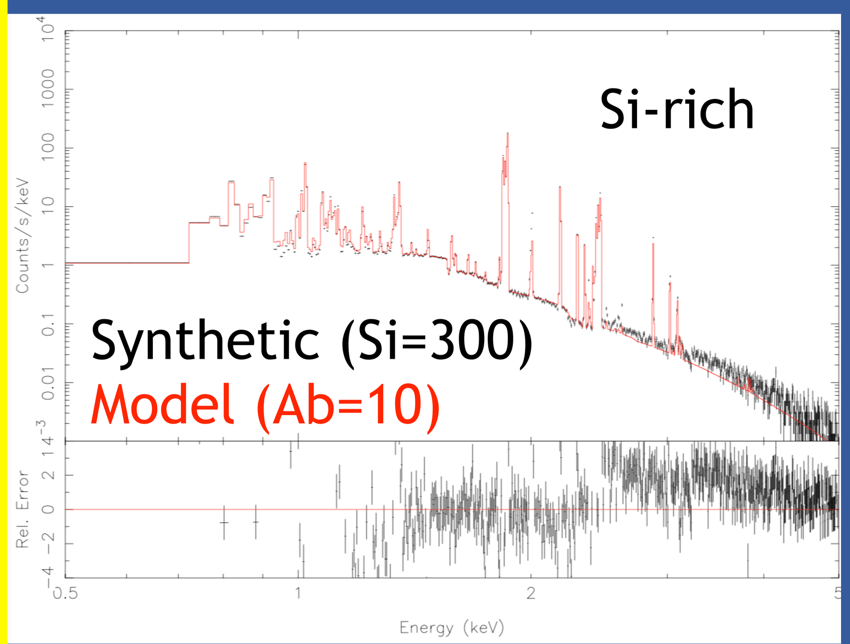
A possible future detection: jet of the Cas A

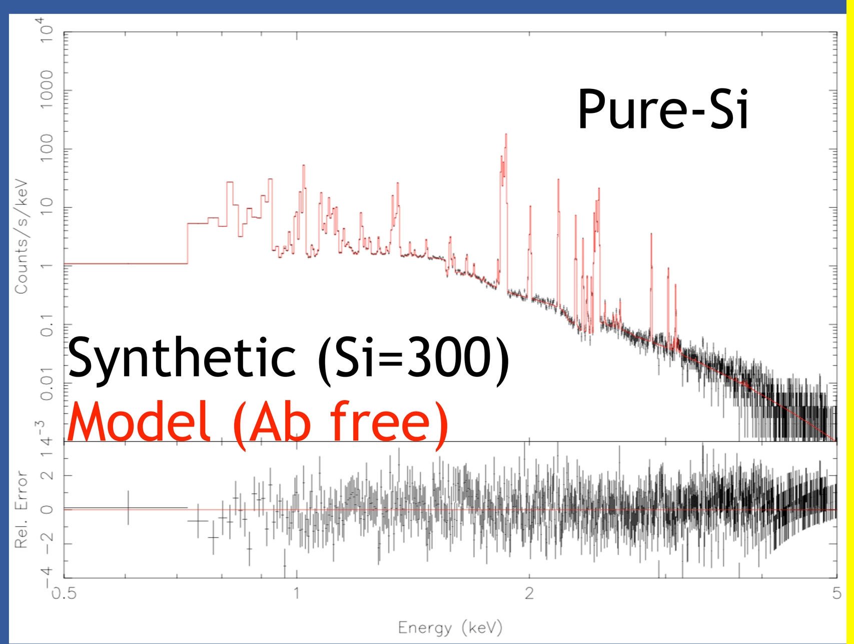
We derived from MHD simulations of Cas A (Orlando et al. 2016) abundances, temperatures, emission measures and ionization parameters of the plasma in the jet region. Can a model with such parameters lead to a spectrum with bright RRC?



Synthetic XRISM spectrum of the Cas A jet

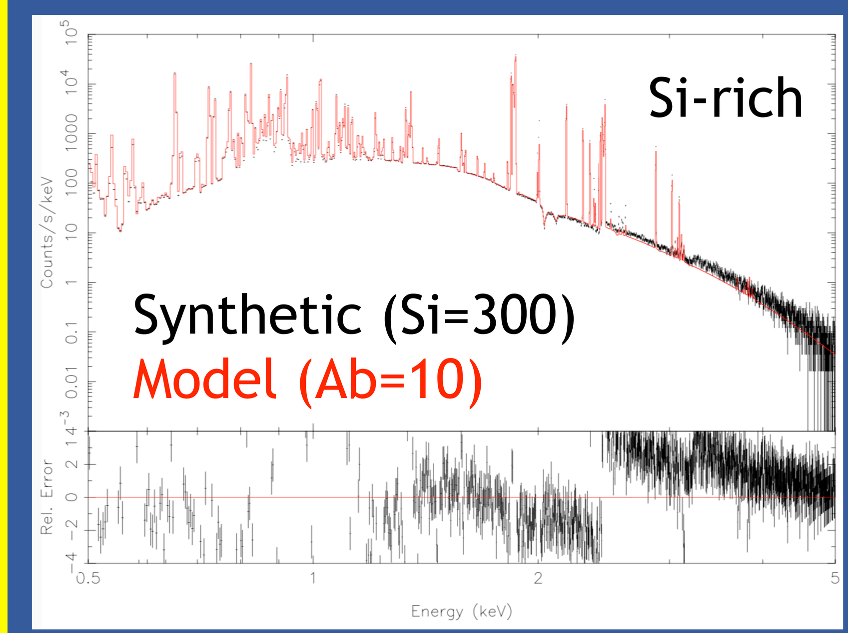
The CasA synthetic spectra (100 ks), folded with the XRISM response matrix, show a bright edge of recombination at 2.5 keV. Only a ISM+PureSi model could fit the spectrum.

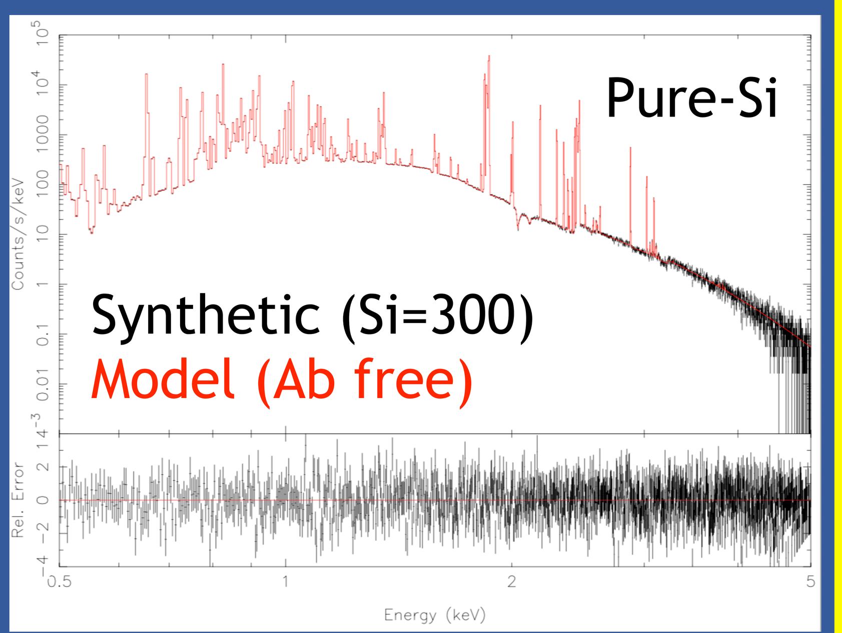




Synthetic X-IFU spectrum of the Cas A jet

Thanks to the bigger effective area of ATHENA, with X-IFU it will be possible to detect pure-ejecta plasma even with low exposure times (~10 ks)





Athena X-IFU and XRISM observations will be able to pinpoint the presence of pure-metal plasma and correctly recover the mass of the ejecta.