The Effect of Metallicity on Nucleosynthesis in Type Ia Supernovae

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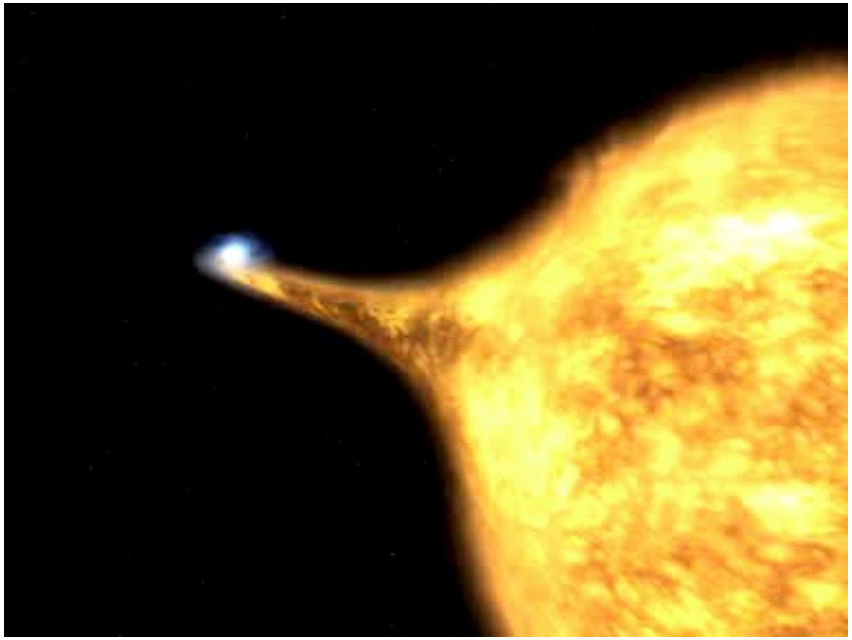
Type Ia Supernovae



[NASA]

Stars with a main sequence mass between 0.85 and 8 solar masses form C/O white dwarf.

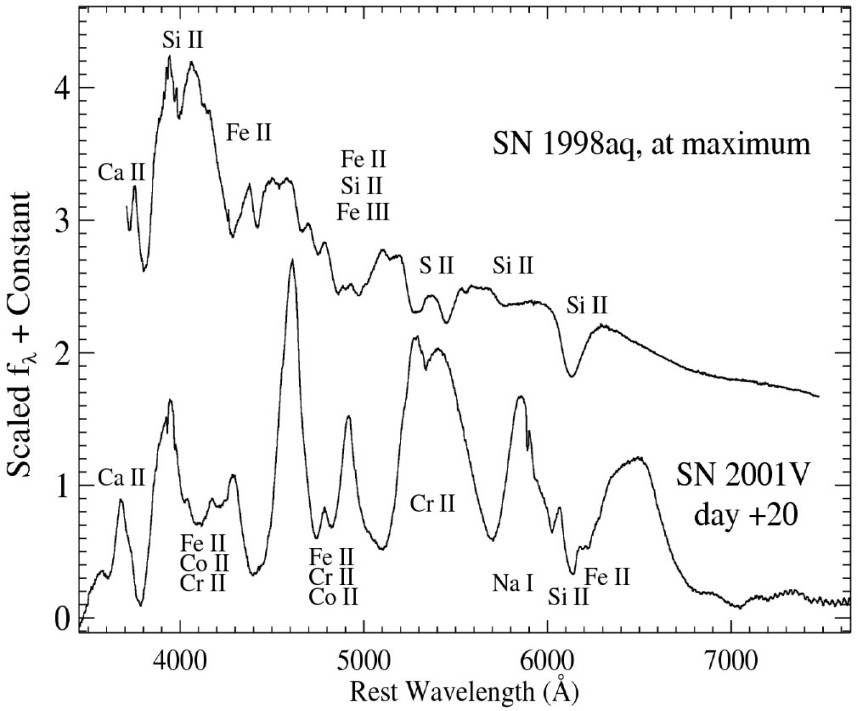
A single degenerate binary system where the non-degenerate star accretes onto the white dwarf.

Thermonuclear incineration of a C/O white dwarf near the Chandrasekhar limit (1.4 Solar Masses). [see Hillebrandt & Niemeyer 2000]

What do we really know?

All we know about SNe Ia comes from observing the end results. We know very little about the progenitors.

2010 Astronomy and Astrophysics Decadal Survey finds “What are the progenitors of Type Ia supernovae and how do the explode?” to be one of the top questions for the next decade.



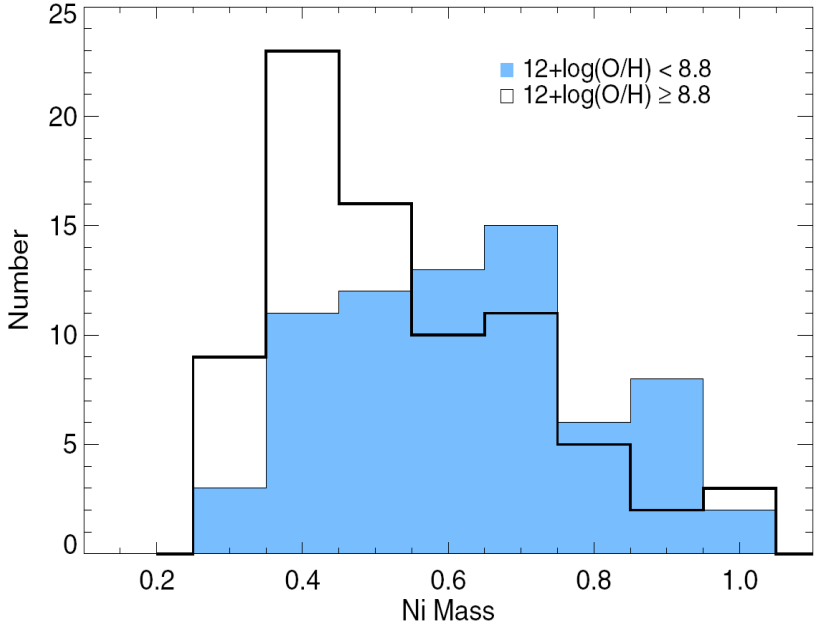
[Matheson et al. 2008]

Why Metallicity

Surveys have shown that SNe Ia have some knowledge of the galaxy that they are in.

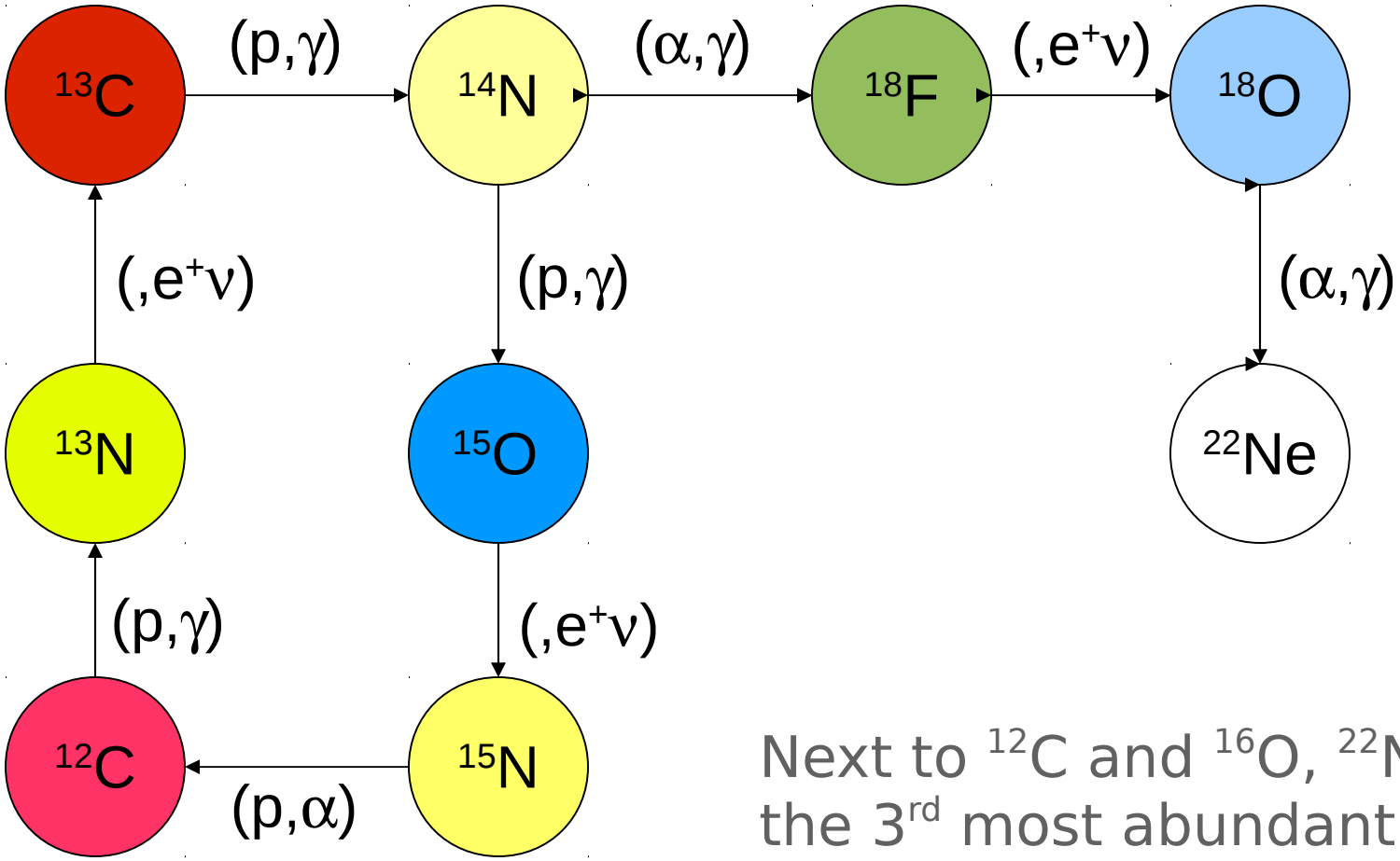
Composition is determined from host galaxy photometry.

Ni mass is determined from Luminosity



[Howell et al. 2009]

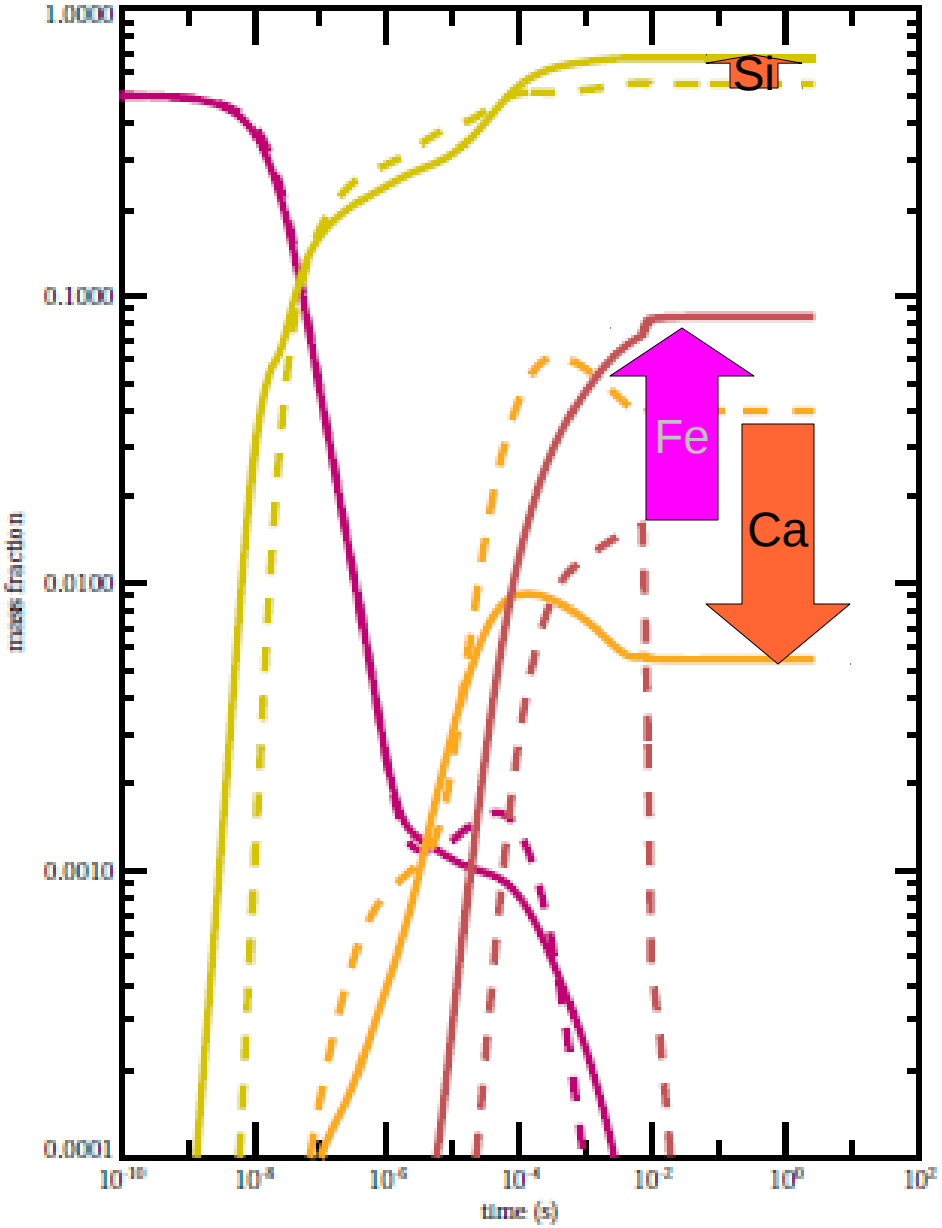
Reactions that take place during core He burning in the giant phase of stellar evolution



Next to ^{12}C and ^{16}O, ^{22}Ne is the 3rd most abundant nuclide in a WD.

Post Processing

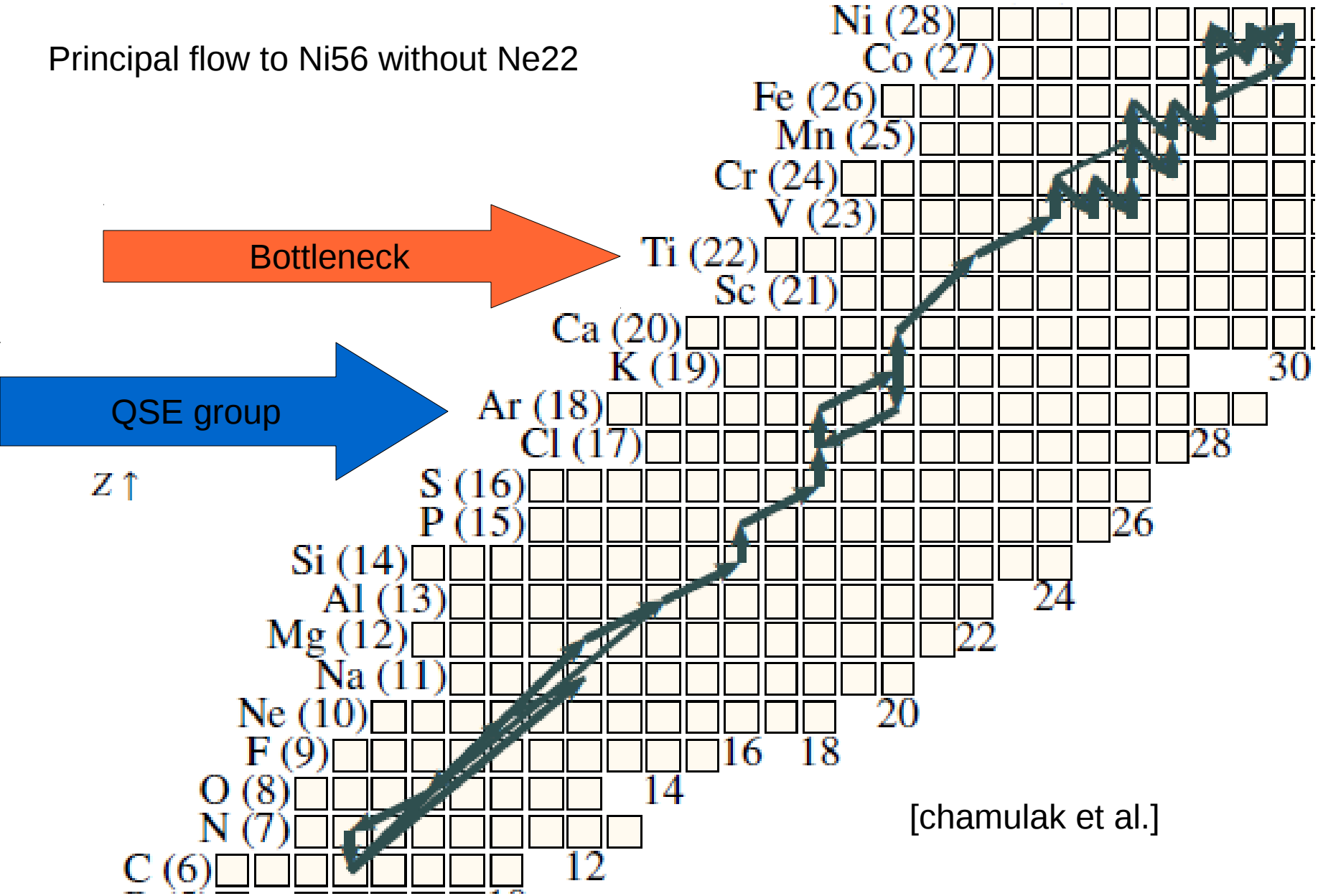
- Post process simulation by Dean Townsley.
- We follow a small chunks of mass and and calculate the nucleosynthesis
- We very the abundance of Ne22 in the post processing



Going from no Ne22 to 3x solar metallicity of Ne22 causes the production of Si, and Fe to increase, and the production of S, Ar, Ca all to decrease.

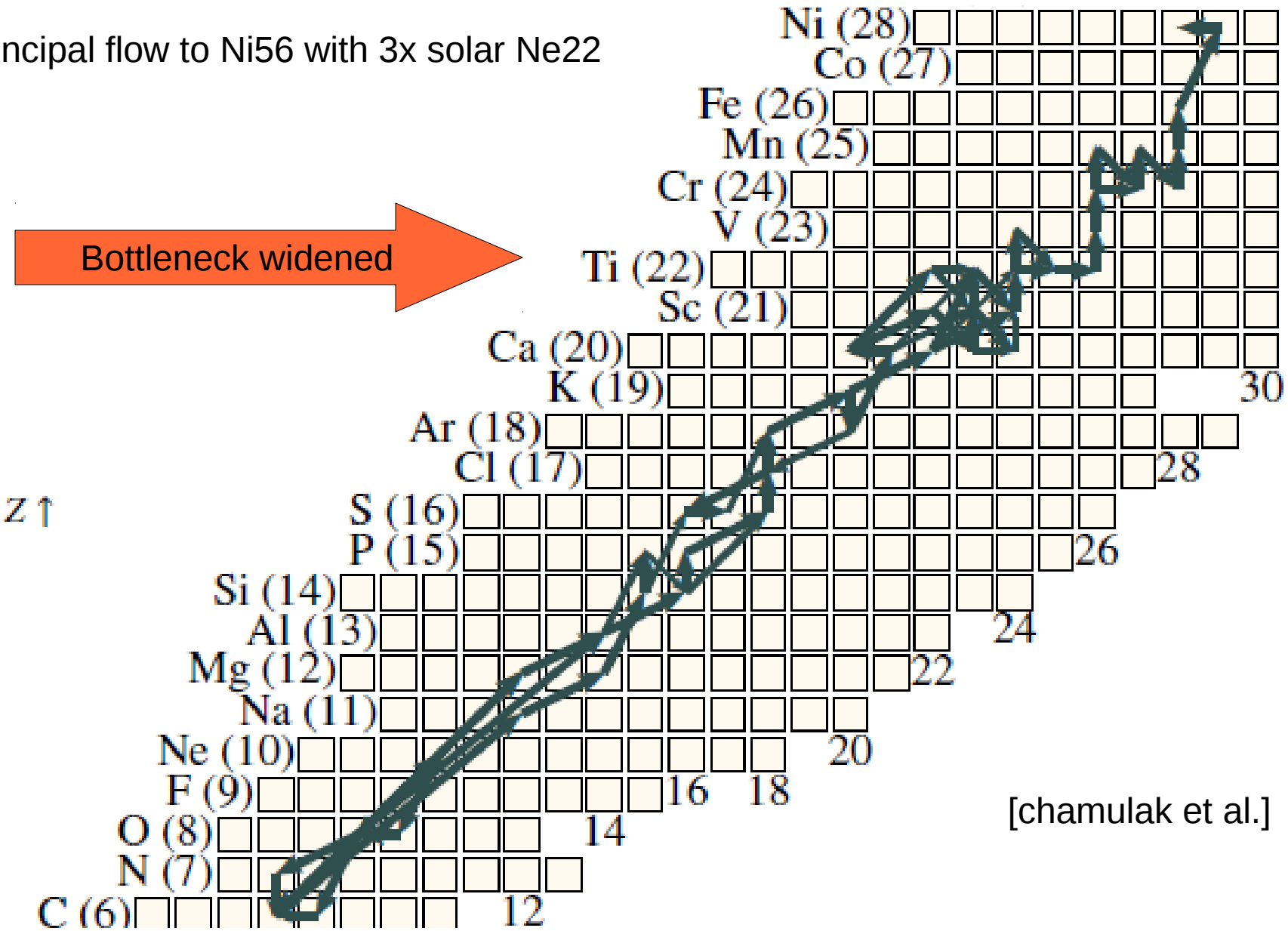
[chamulak et al.]

Principal flow to Ni56 without Ne22



[chamulak et al.]

Principal flow to Ni56 with 3x solar Ne22



[chamulak et al.]

Why the increase in Si?

Assume you have Si28 Ca40 and alpha particles in equilibrium.

$$Y(Ca40) = C(T)\,Y(Si28)\,Y(\alpha)^3$$

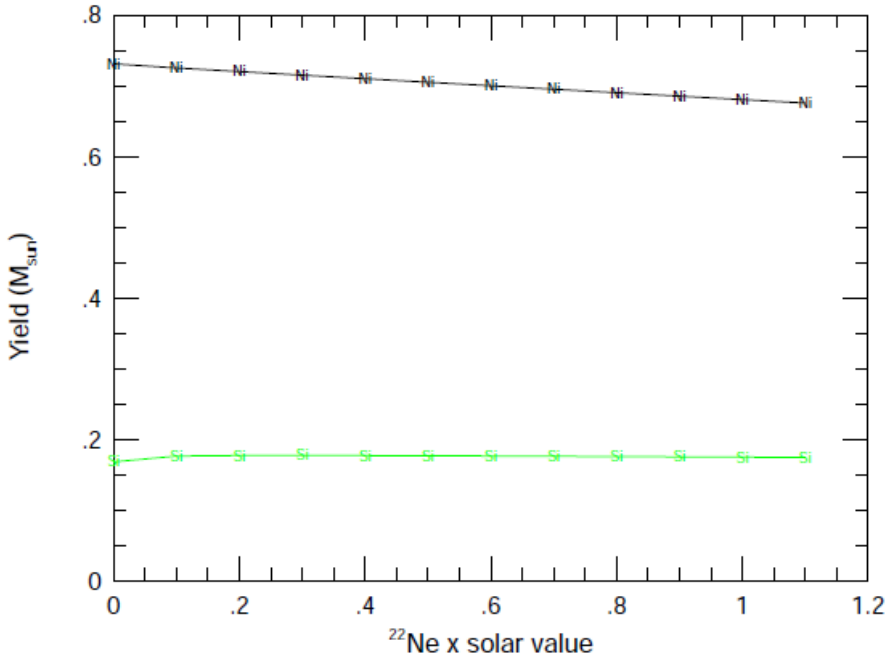
$$\frac{a}{b^3} = \frac{Yf(Si28)}{Yi(Si28)}$$

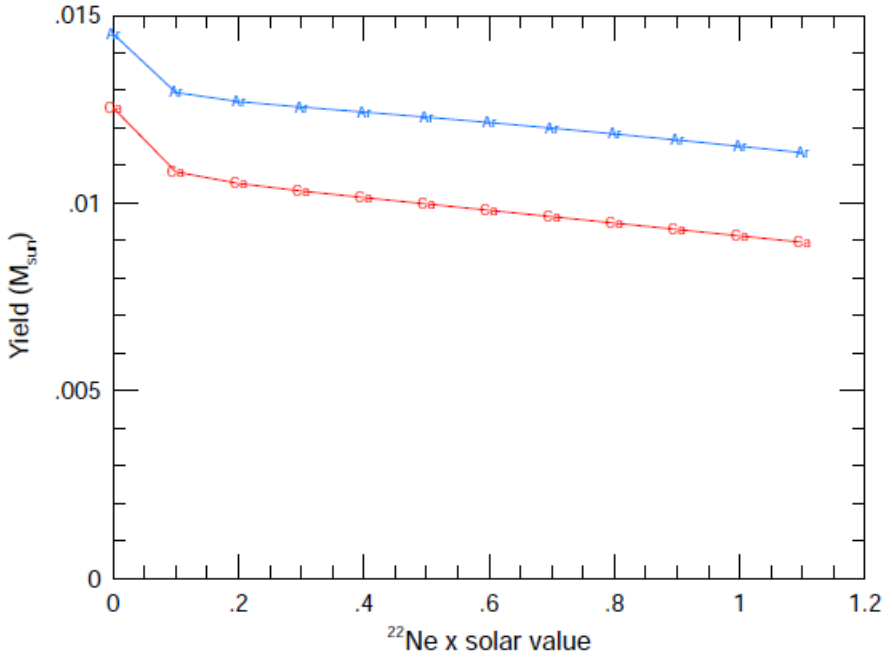
Since b^3 is less then a Yf/Yi > 1

Additional models?

W7 model shows the same trend.

GCD and sub-Chandra models also show the trend





What next?

- Radiation transport calculations to generate synthetic spectra and light curves.
  - Comparison with observations
- Sensitivity study

Conclusions & Collaborators

SNe Ia seam to know something about the type of galaxy they are in.

Metallicity affects the nucleosynthesis taking place in SNe Ia.

There is a systematic trend in the nucleosynthesis of Si group elements with metallicity.

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