THE HIGH FIVES

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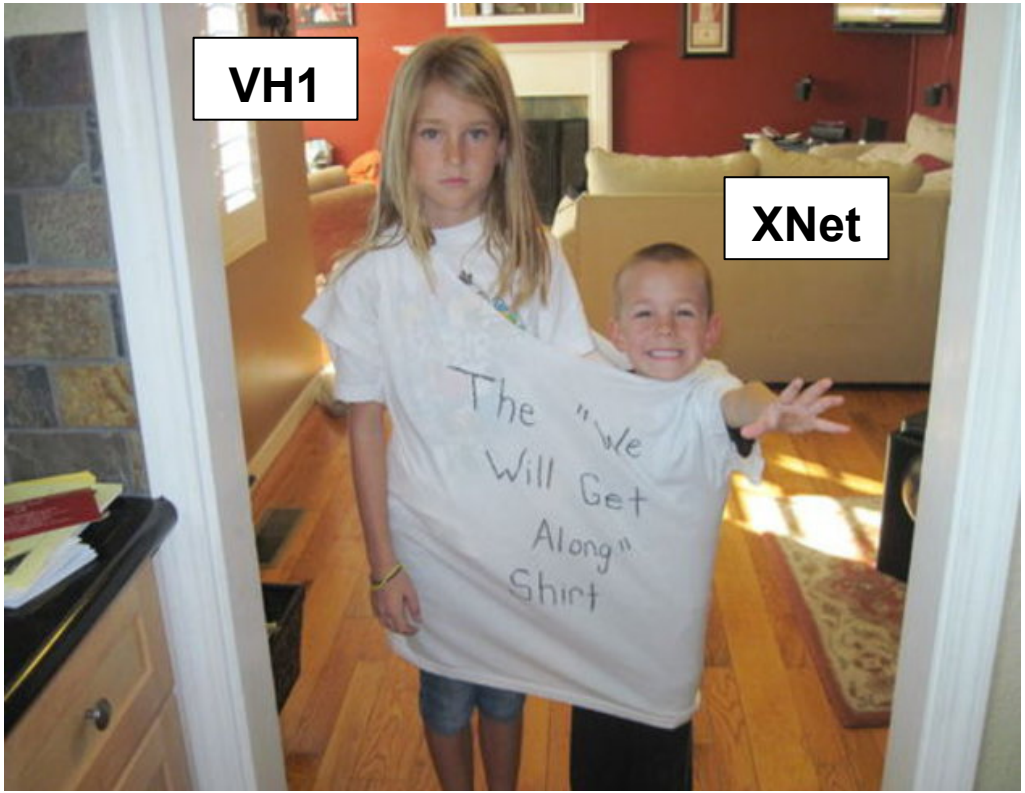
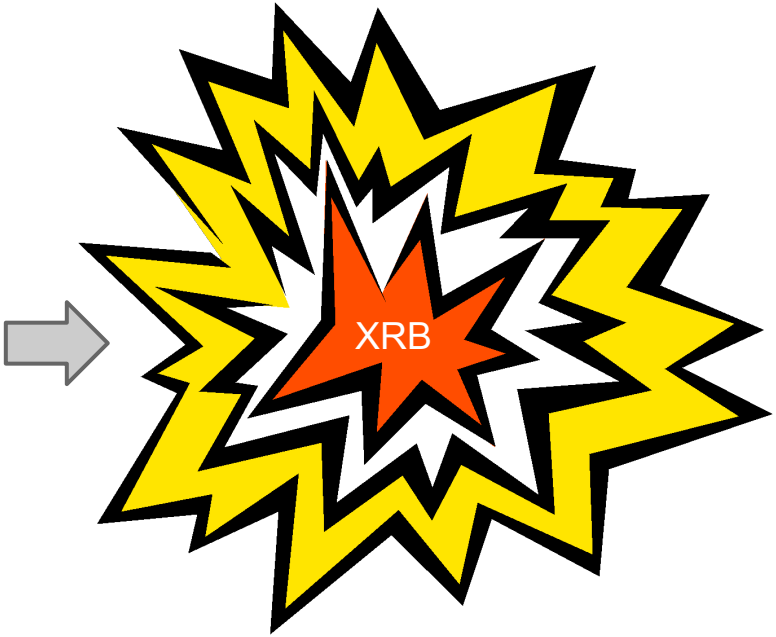
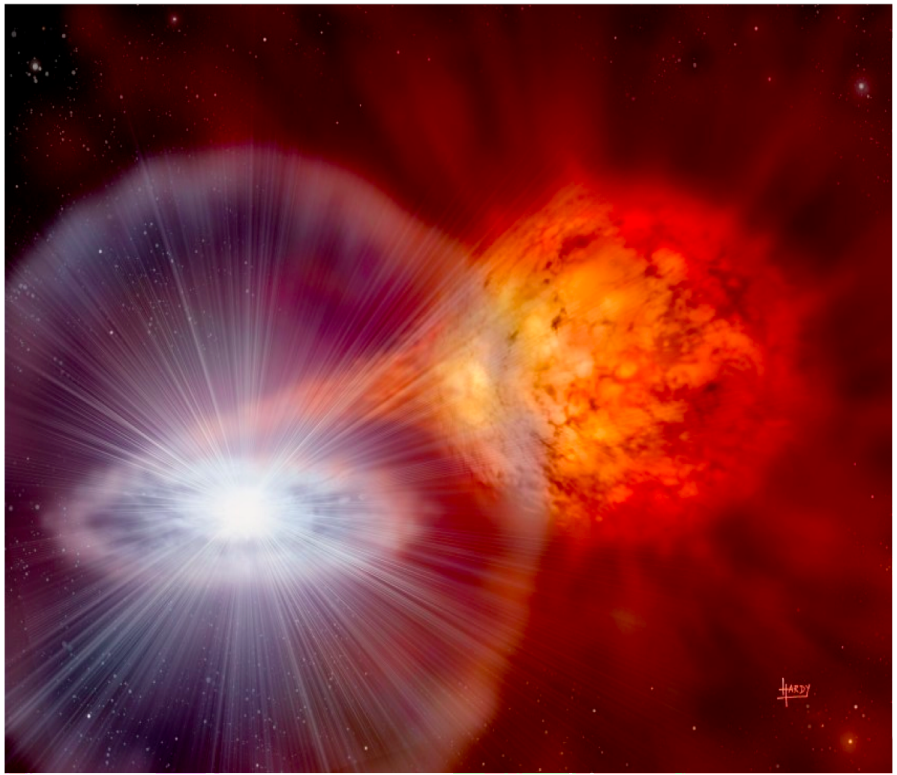
Our Project Goals

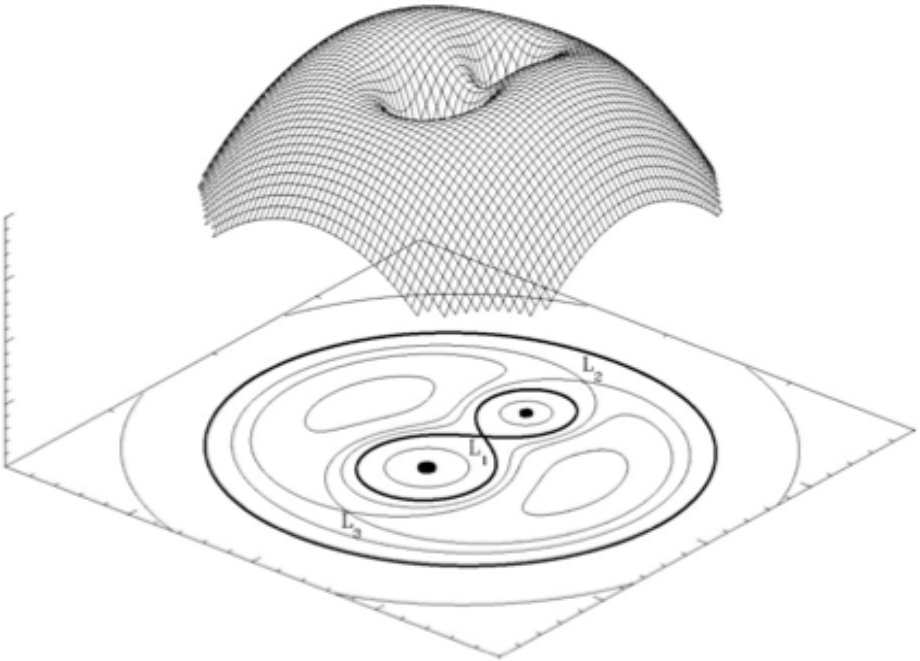
Simulate an X-ray burst using VH1 coupled with XNet



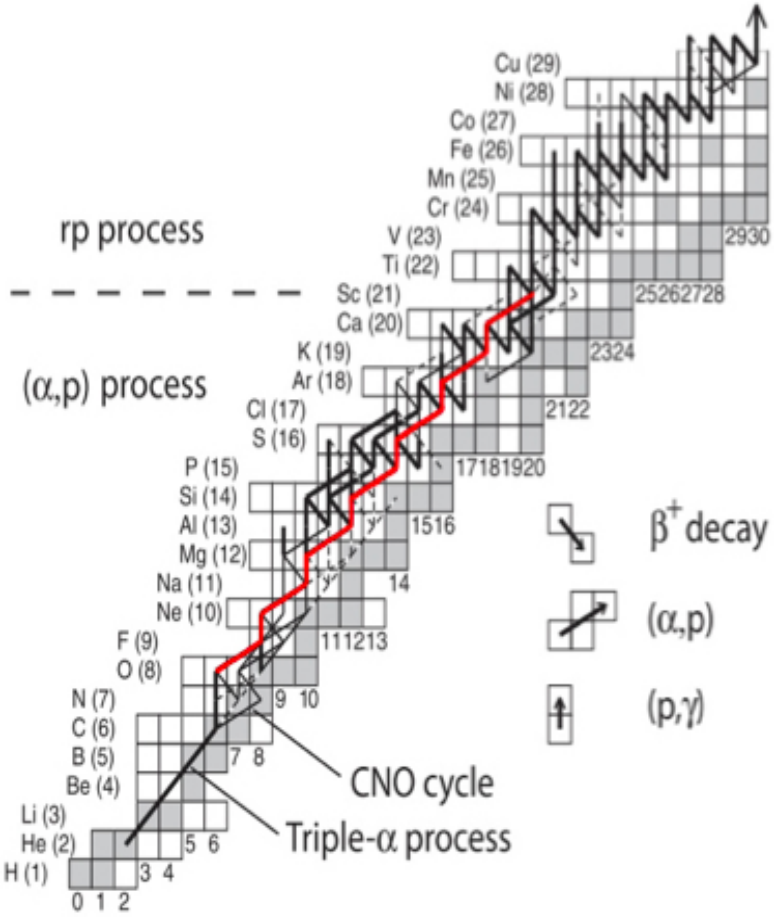


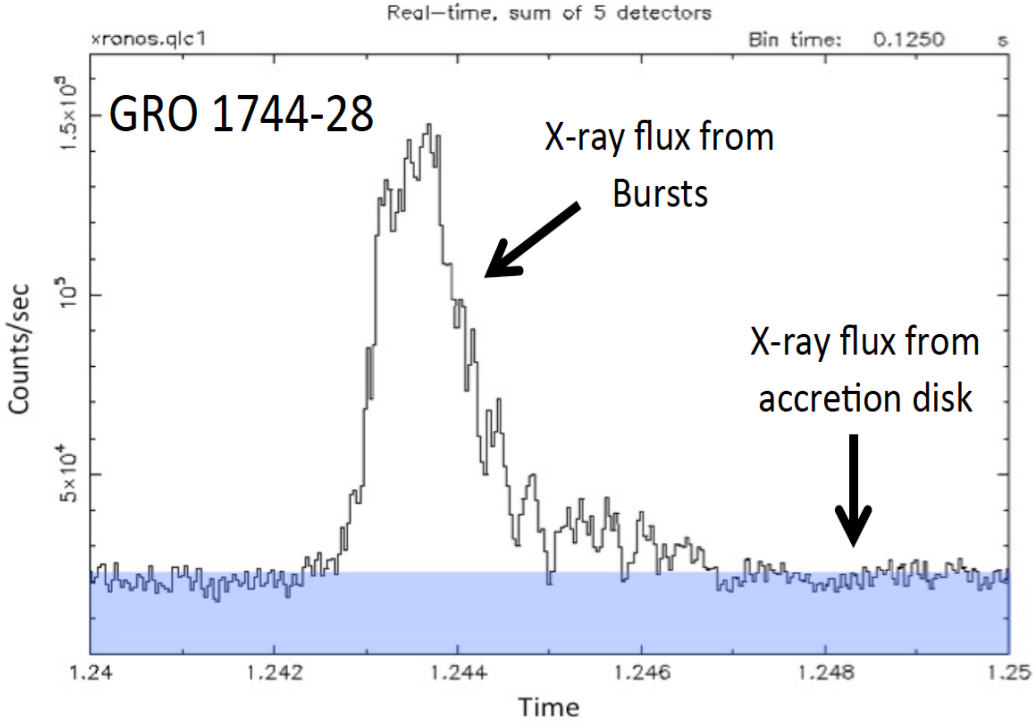
A General Introduction





Nucleosynthesis during XRBs





VH1 : Neutron Star Accretion

Bondi Accretion

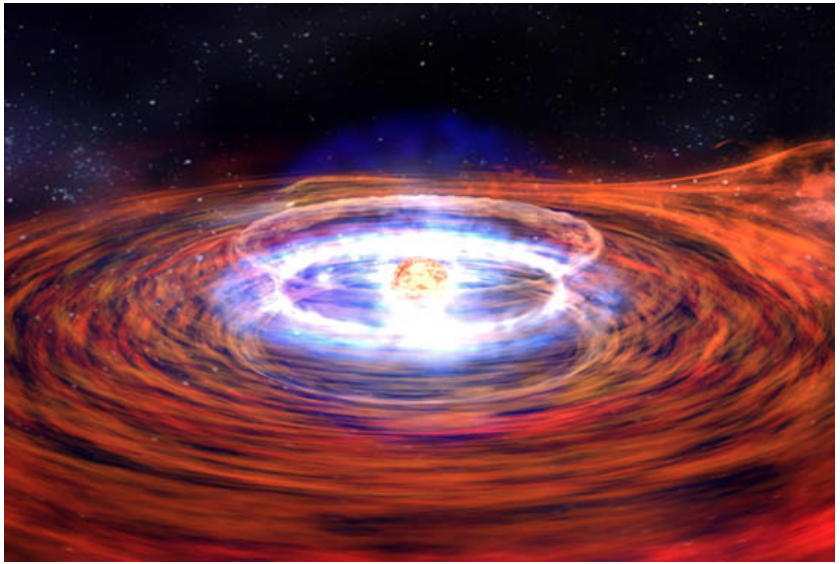
Spherically Symmetric

Gravity Turned On

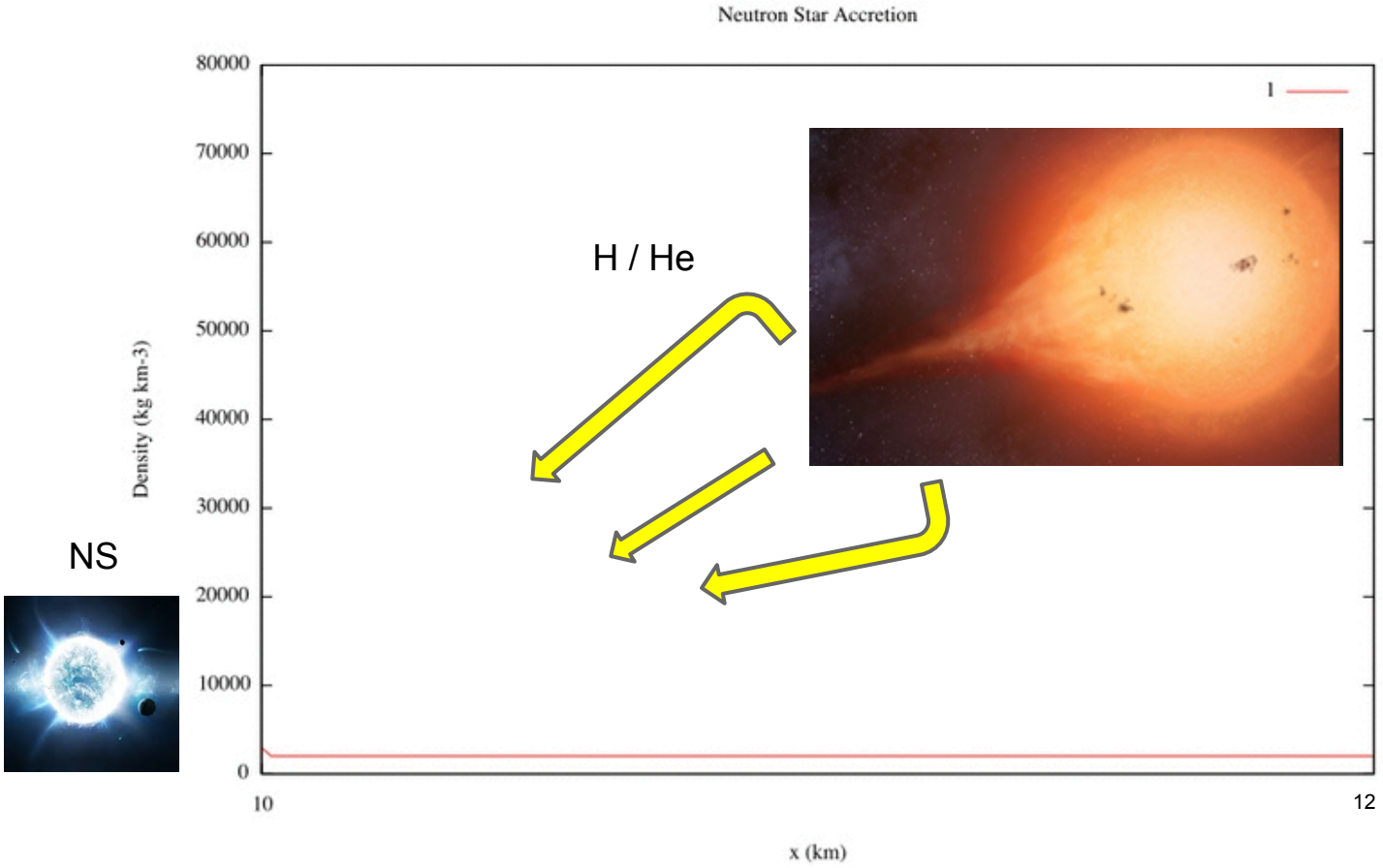
Fixed Inflow Rate

Reflecting on the Surface

```
ngeom  = 2      ! Spherical geometry
nleft  = 0      ! Reflecting at xmin
nright = 2      ! Fixed Value

xmin = 1.e+1             ! x value at left edge of grid
xmax = 5.e+1            ! x value at right edge of grid

uright = 3.69e-2 !-2
pleft  = 2.66e-7 ! Ambience Pressure
dleft  = 2.e+3    ! Ambience Density

gam    = 5./3.
```

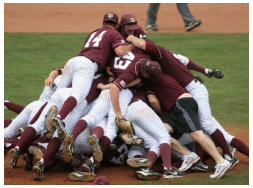


Density

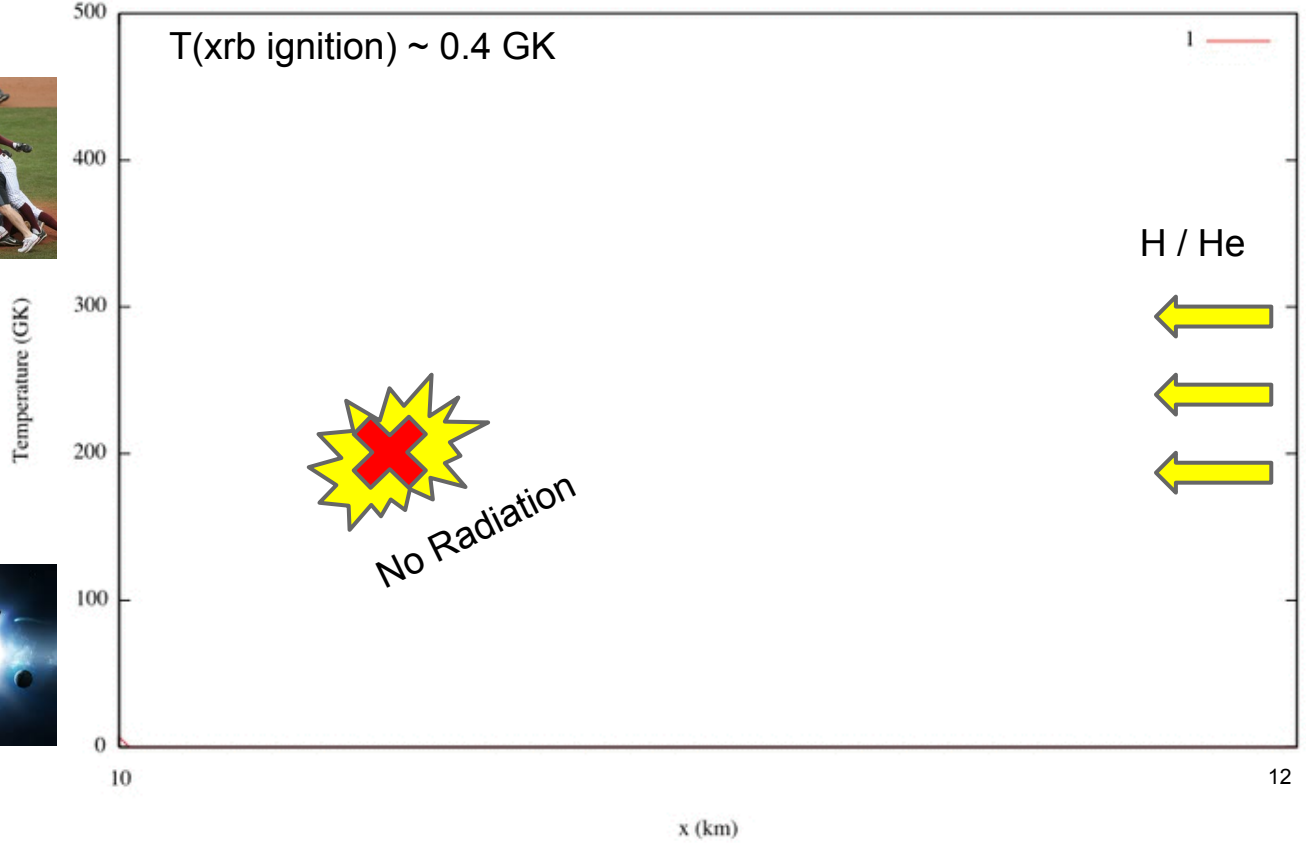

Neutron Star Accretion
80000
70000
60000
50000
40000
30000
20000
10000
0
Density (kg km-3)
1
H / He
NS
10
12
x (km)

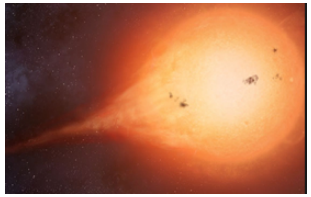
Temperature

Pile up



NS





Parameters

To model accretion process we need the following:

SEDIMENTATION AND TYPE I X-RAY BURSTS AT LOW ACCRETION RATES, Peng, et al

- Neutron Star Radius
  - 10 km
    - taken to be the same as in Peng et al
- Neutron Star Mass
  - 1.4 solar masses
    - taken to be the same as in Peng et al
- Accretion Rate
  - from 10^15 g/s
  - to ~10^17 g/s
    - range explored in Peng et al
    - Along with density determine boundary conditions of spherical model

Parameters

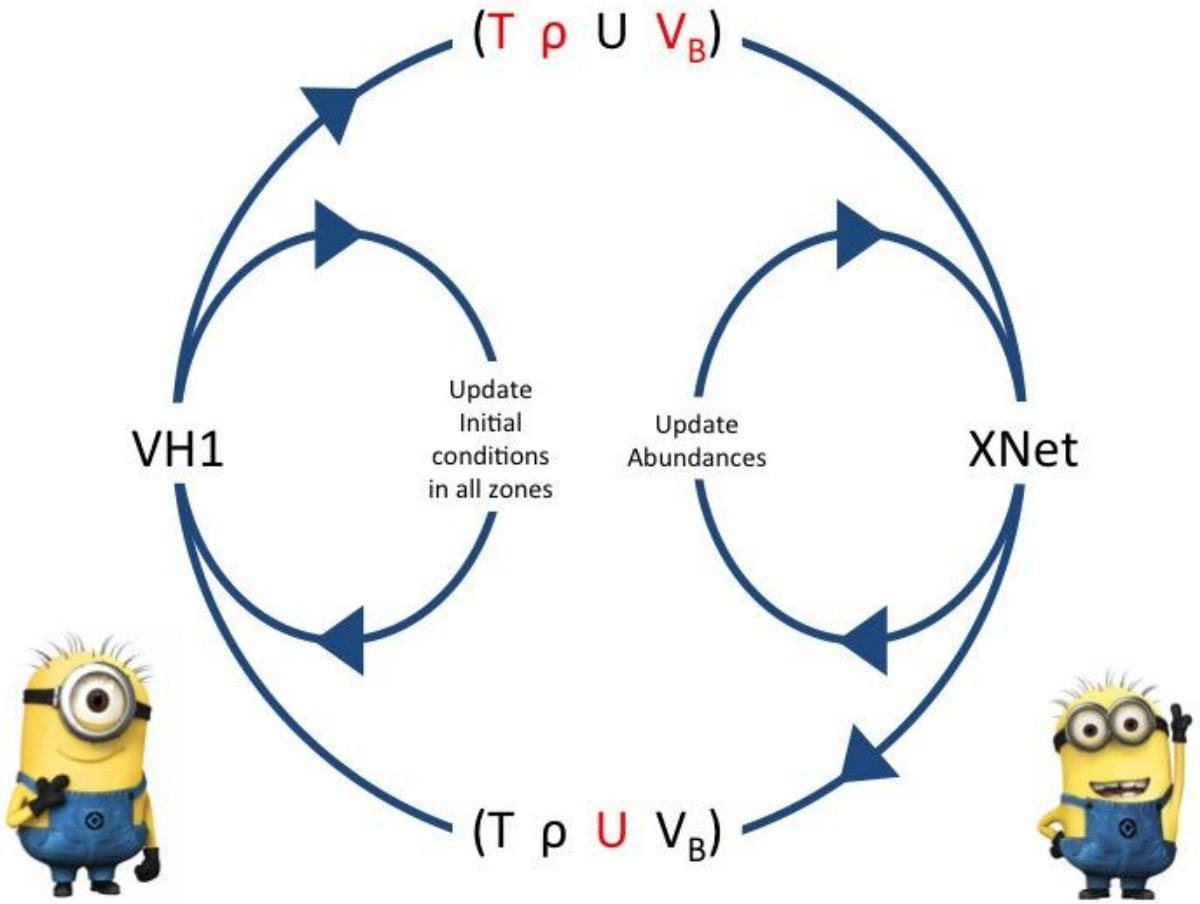
- Density of Accreting Material
  - taken to be 0.2 g/cm^3
    - stellar envelope density for some RGB stars
    - note: this is somewhat arbitrary
- Burst Location
  - within 4m of neutron star crust
    - H. Schatz lecture

Problems

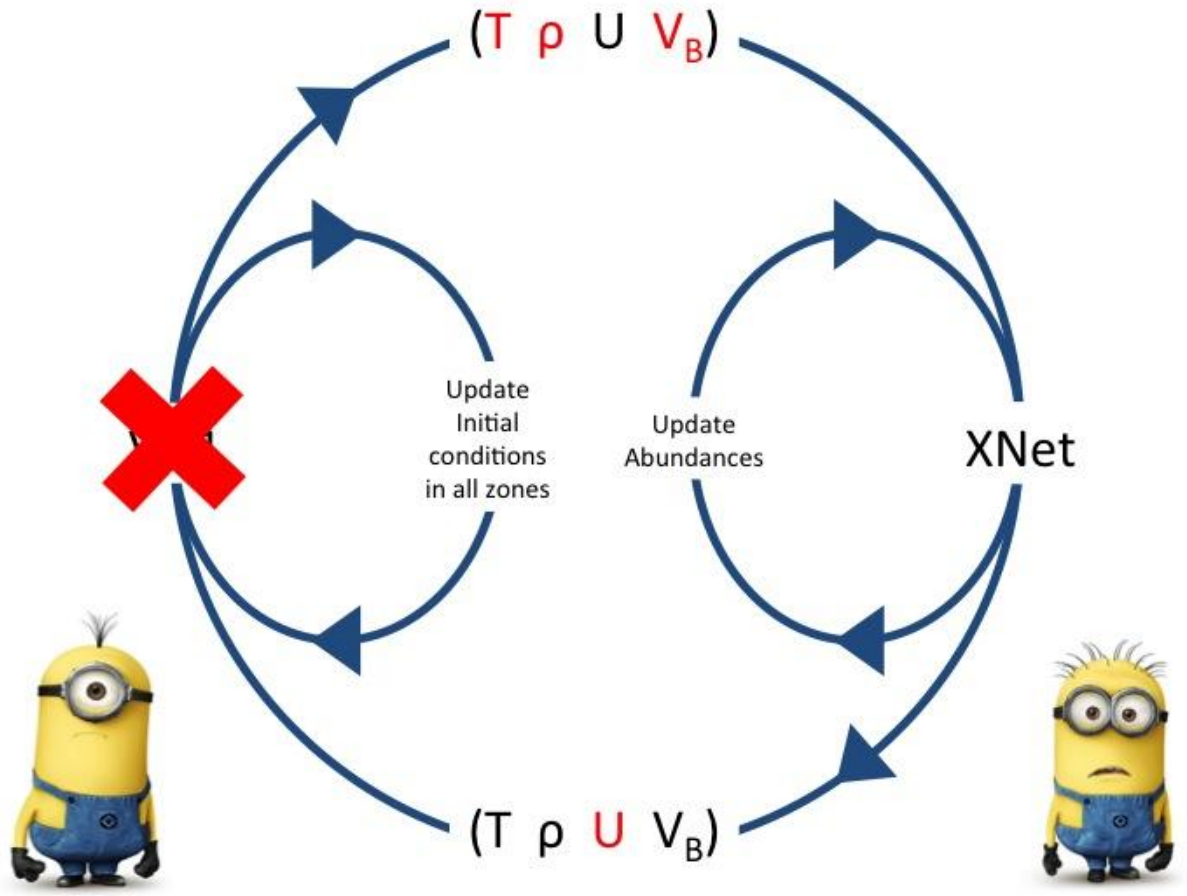
Ultimately the accretion model failed to produce the required temperatures and pressures for the necessary nuclear reactions.

- Bondi Accretion Model does not preserve the length scale of the problem at available resolution.
  - Bondi requires outer radius to be much greater than (100 to 1000 times) the inner radius.
    - To preserve the scale of the burst we needed our outer radius to be ~ 5x the inner.
- Did not take into account the need for a cooling mechanism until too late in the project.
  - Gravitational binding energy was converting to internal energy of the gas.
    - Temperatures were reaching in excess of 100 GK.
      - This is far above the NSE boundary
      - Needed ~0.4 GK for CNO cycle
  - Introduction of radiative cooling was problematic.
    - Cooling ~ T^3 dT/dr
      - The finite difference was unstable in the presence of the shock front associated with the poorly scaled Bondi model.

Coupling VH1 and XNet

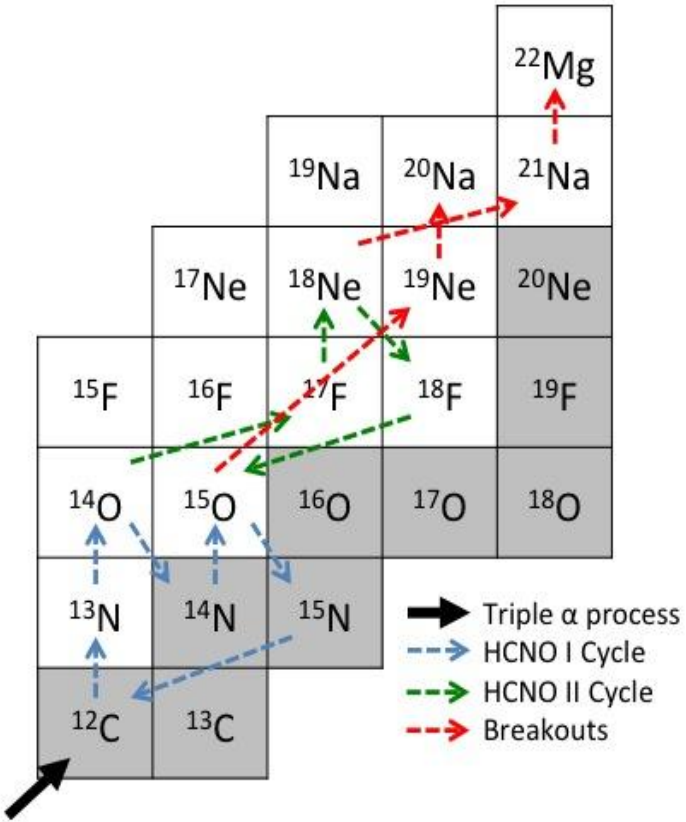


Coupling VH1 and XNet



Our (New) Project Goals

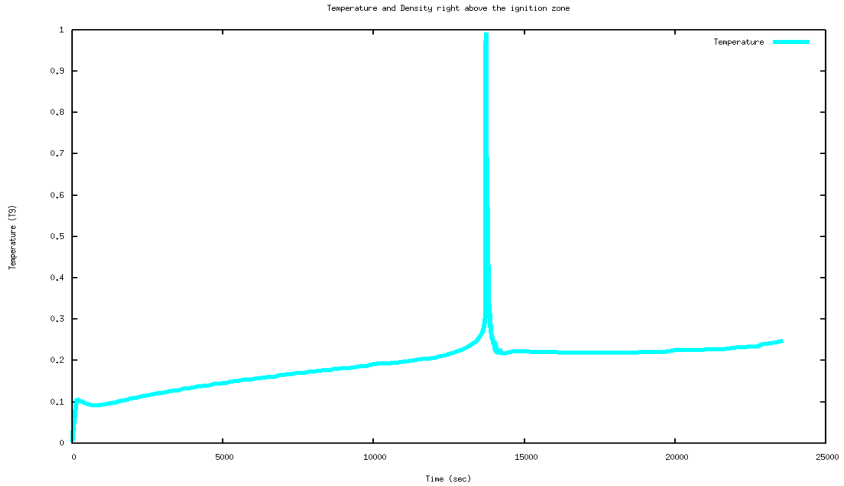
Post processing sensitivity study of $^{15}O(\alpha, \gamma)^{19}Ne$ using XNet



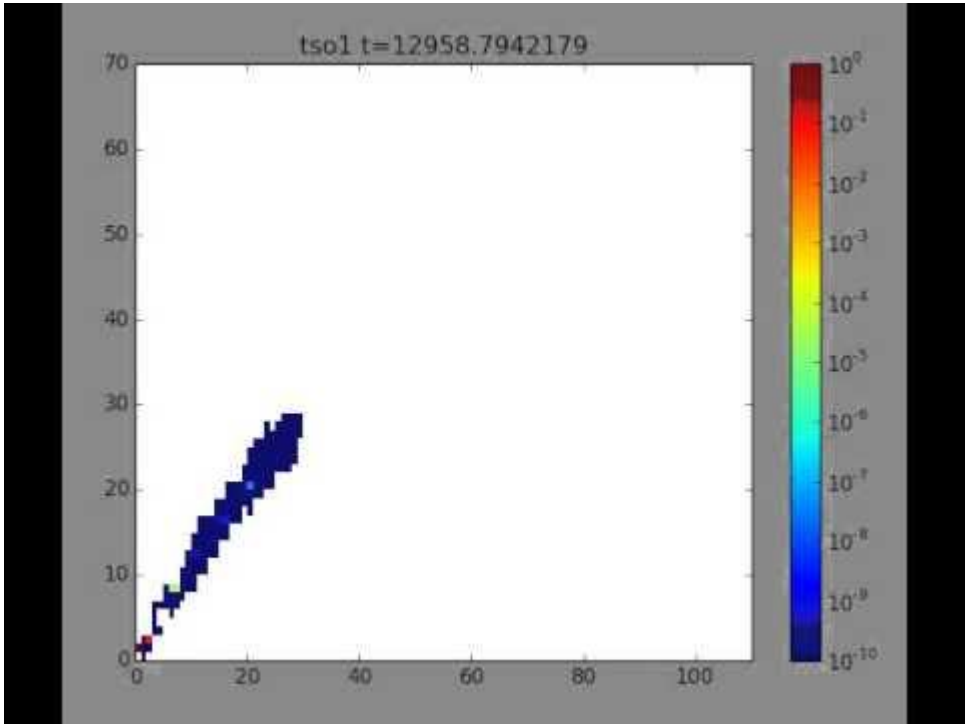
Given the Temp/Den profile from Fisker *et al.*

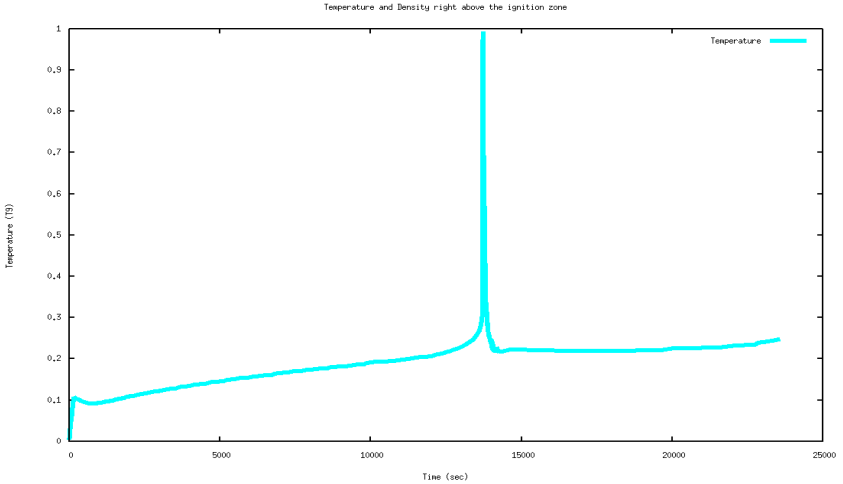
Vary rate of $^{15}O(\alpha, \gamma)^{19}Ne$ by 5%

See what happens!

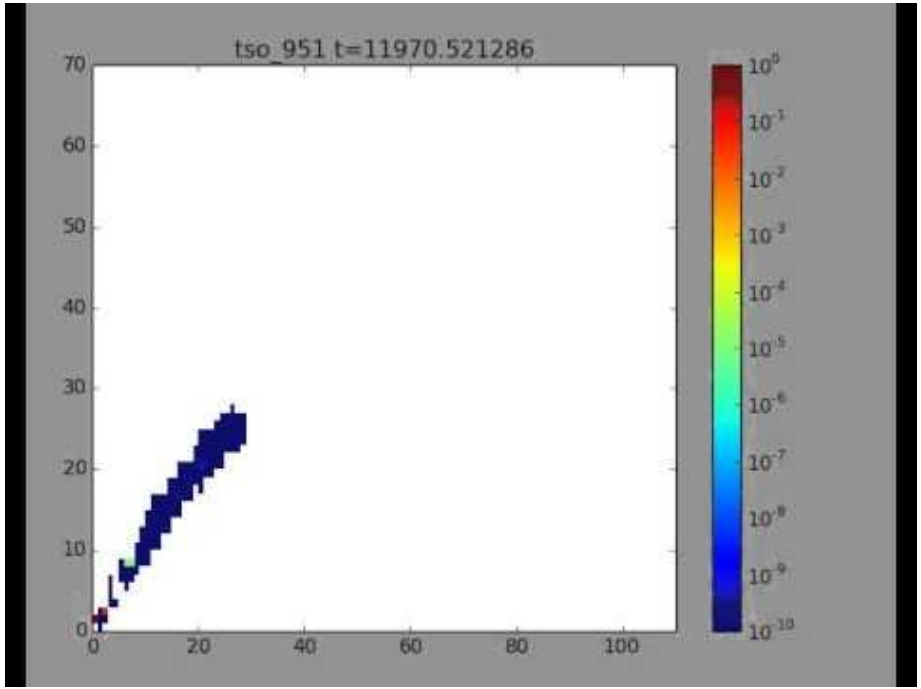


$^{15}O(\alpha, \gamma)^{19}Ne$ Reaction Rate

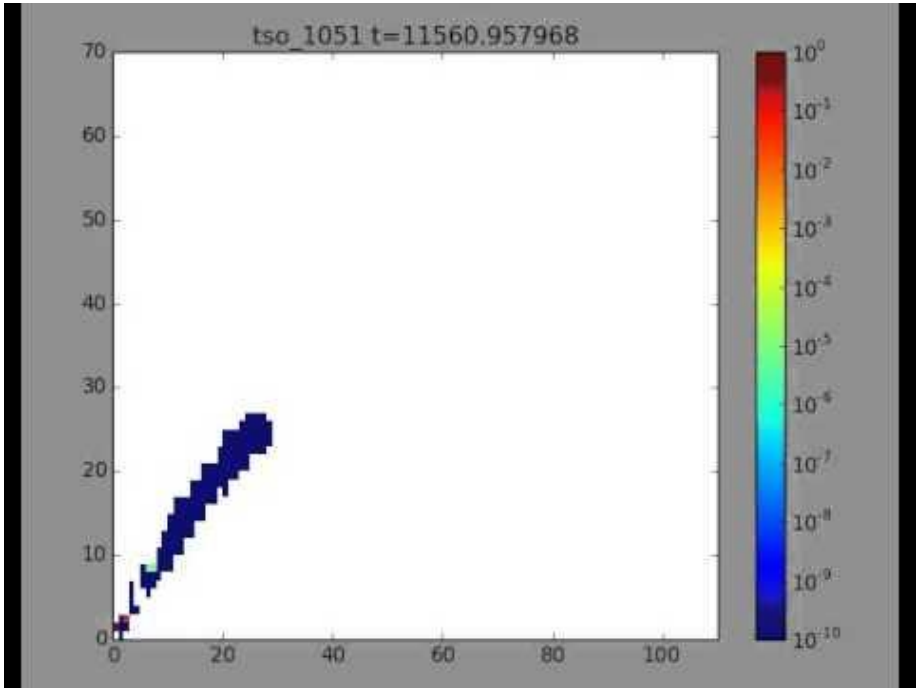




$^{15}O(\alpha, \gamma)^{19}Ne$ Reaction Rate



5% Increase



5% Decrease

Here is a Type 1a SN Kitten