

## Questions of the Day

- Why can high mass stars use more varieties of fuel over their lives, compared to low mass stars?
- How are planetary nebula formed?
- Why are planetary nebulae colorful?
- What kind of star is leftover after the formation of a planetary nebula?
- Why are white dwarfs different than main sequence stars?
- Why do white dwarfs eventually fade?
- Why don't white dwarfs collapse?
- How does degeneracy pressure behave?

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## Administrative Stuff

- Midterm a week from Wednesday!
- 50 multiple choice questions in 50 minutes.
- Bring a scantron form!
- PDFs of old midterms are now posted on the syllabus, under 2/10
- Remember all those office hours? Great for reviewing old midterms!
- CLUE review session 2/9 in the evening.
- Will cover everything we cover this week -- keep in mind that we're 1 lecture ahead of the syllabus

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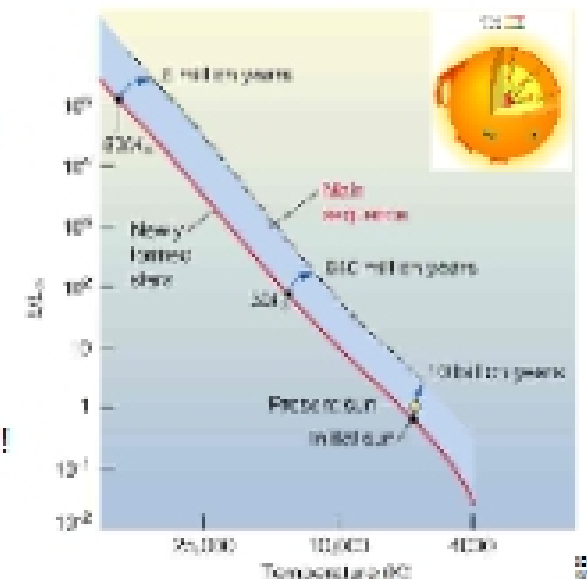
## Rules for the Day

- When Stuff falls inwards, it heats up.
- When Stuff falls inwards, it gets denser too.
- Higher temperatures and densities may allow more positively charged nuclei to interact and fuse.

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## An example: The main sequence brightens with time.

- $4\text{H} \rightarrow 1\text{He}$  means fewer particles.
- Fewer particles = less pressure
- Gravity wins a little more all the time!
- Stuff falls in (i.e. star contracts)
- Core gets hotter!
- Fusion happens faster!
- More energy is released per second



2

22

# Like everything else, the fate of stars depends almost entirely on **MASS!**

## The Thought Process of a Desperate Star...

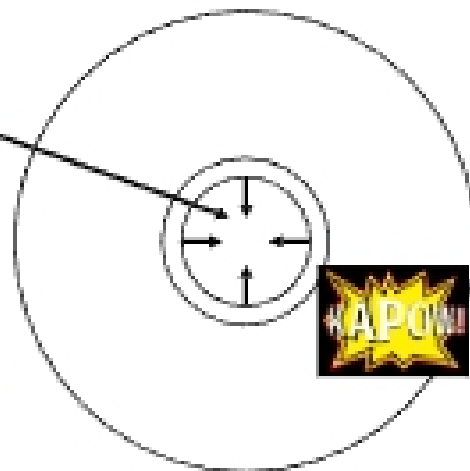
- Oh crap, I'm out of fuel.
- There goes my pressure support, I'd better collapse my core.
- Oh wait, now I can start burning my old fuel just outside the core. Whew.



But, the inert core still keeps collapsing!

Shell burning can't heat up the core effectively.

The core still doesn't have enough pressure support!



But, the inert core still keeps collapsing!

But, as the core collapses, it heats up!

It also gets denser!



All high speeds, nuclear fusion starts  
because for the strong nuclear force  
to be felt, they're close.

Maybe it gets hot & dense enough for this?  
(with He, not H)

## The Thought process of a Desperate Star...

- Well, the shell burning helps, but my core keeps collapsing.
- Hmm. My core is heating up.



### Lower mass stars say:

- My gut isn't getting hot enough to burn any other kind of fuel.
- Dang. I'm screwed.
- Denial. Rage. Acceptance. Death.

## The Thought Process of a Desperate Star...

- Well, the shell burning helps, but my core keeps collapsing.
- Hmm. My core is heating up.



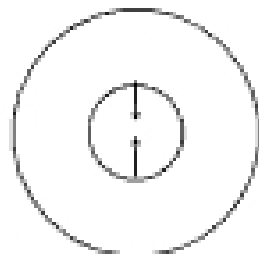
### Higher mass stars say:

- Dang, my core is hot!
- Hey, I can burn up this next heavier element in my core.
- Wahoo! Reprieve!

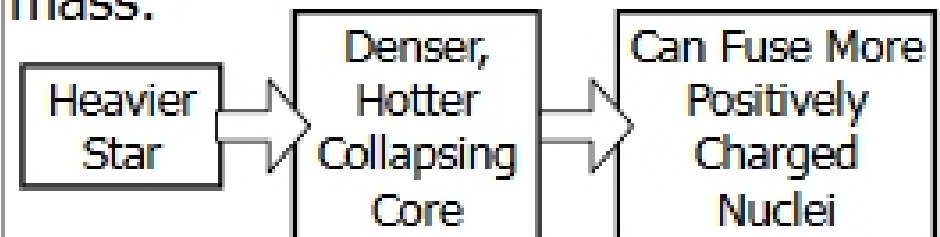
But only while the next fuel lasts! Cycle repeats!

## This process works no matter what the original fuel was

- Oh crap, I'm out of ~~Hydrogen~~ ~~Helium~~ Carbon.
- There goes my pressure support, I'd better collapse my core.
- Oh wait, now I can start burning my old fuel just outside the core. Whew.



## Where the cycle ends depends upon mass.



- Very Low Mass: Can't burn anything by H.
- Solar Mass: Can burn He, but nothing else.
- Very High Mass: Can burn anything!