Conditions for Dark Matter Ignition of White Dwarf Stars

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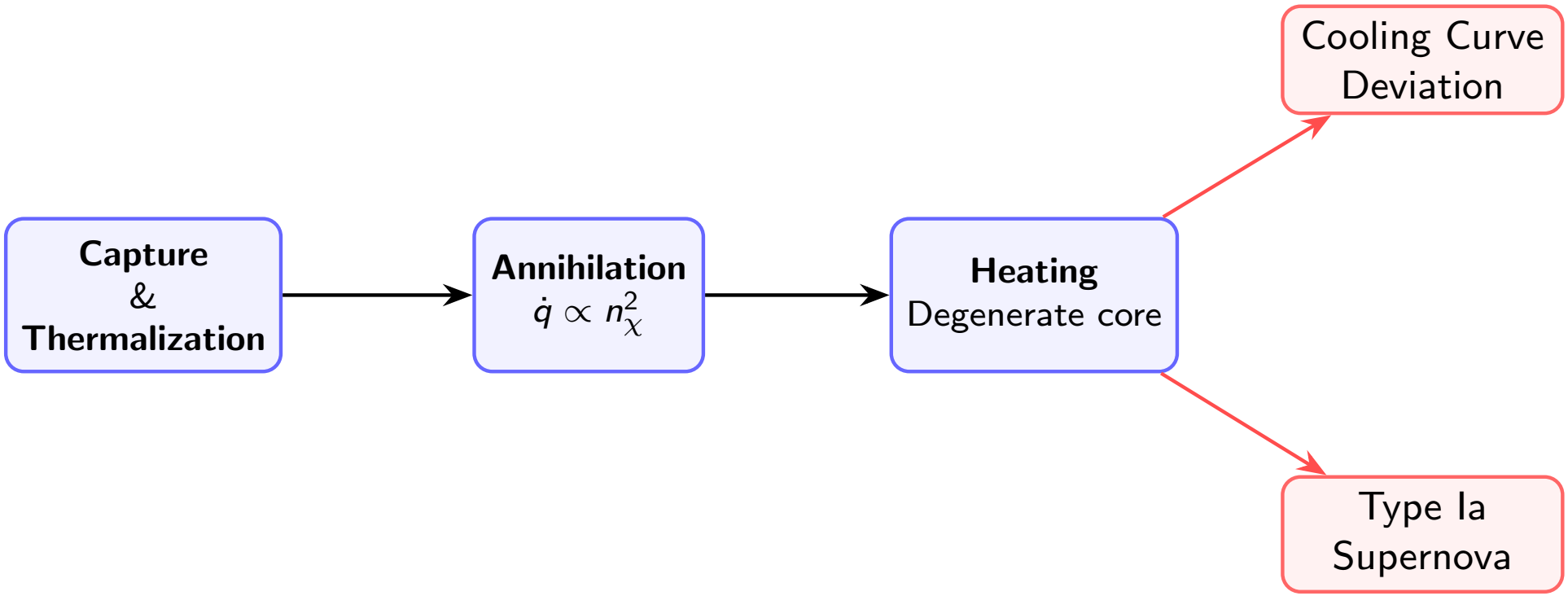
The Mechanism



1. WIMPs scatter off nuclei, lose energy → gravitationally bound
2. Repeated scattering → settle in tiny sphere at core ($r_{th} \sim 30$ m)
3. High density → annihilation heating
4. Degenerate matter can't cool by expansion → two possible outcomes

Why Degenerate Cores Matter

Normal stellar matter:

- Pressure $\propto$ Temperature
- Heating $\rightarrow$ Expansion
- Expansion $\rightarrow$ Cooling
- Self-regulating

Degenerate matter:

- Pressure $\propto$ Density
- Heating $\rightarrow$ No expansion
- Temperature rises unchecked
- Vulnerable to runaway

Observable Signatures

Two clear predictions:

1. **Population deficit**
   - Missing old WDs near galactic center
   - High DM density $\rightarrow$ early ignition

2. **Anomalous heating**
   - WDs "too hot for their age"
   - Deviation from cooling tracks

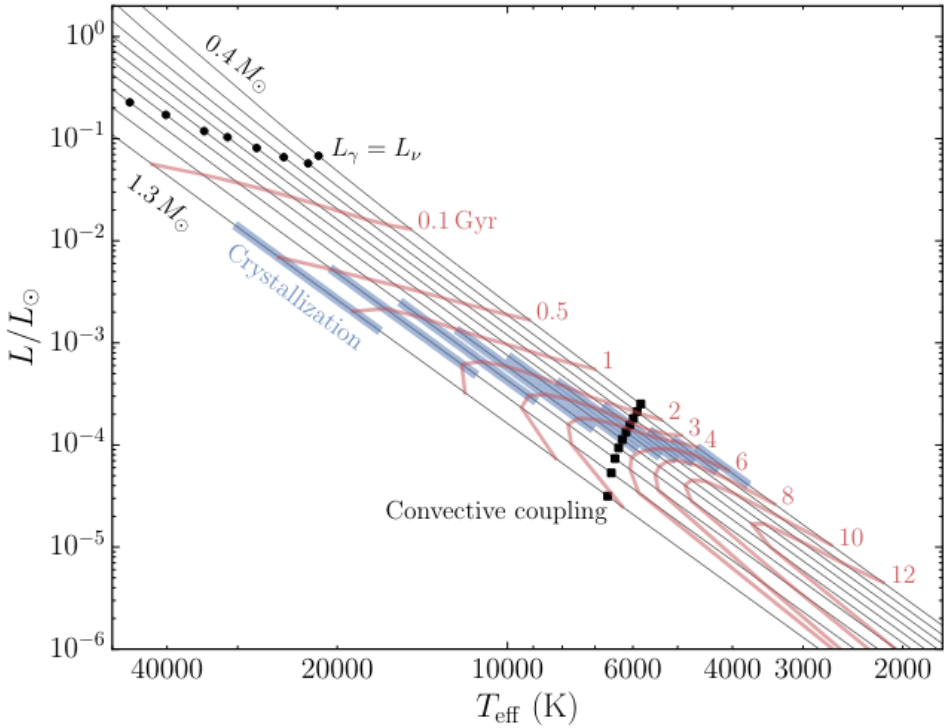


Figure: Saumon et al. [2022]

Observational Feasibility

Why this is testable:

- **Gaia survey:** Millions of white dwarfs catalogued across the universe
- **Statistical approach:** Compare white dwarf populations in high vs. low dark matter density regions
- **Parameter space:**
  - WIMP masses: $10^5 - 10^8$ GeV
  - Cross-sections: $10^{-40} - 10^{-45}$ cm^2
- **Indirect detection:** No need to catch single particles, billions of years of accumulation does the work

The universe provides laboratories we could never build on Earth

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