

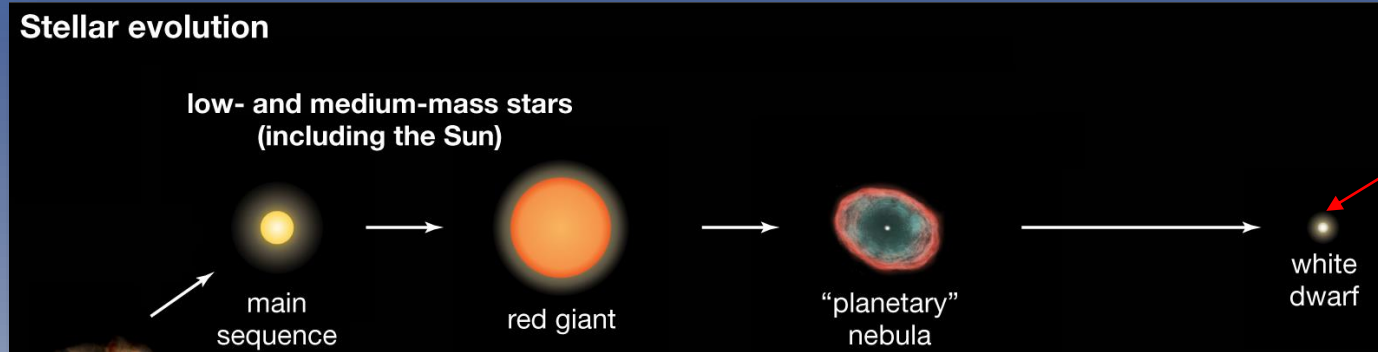


Delayed Detonation Thermonuclear Supernovae With An Extended Dark Matter Component

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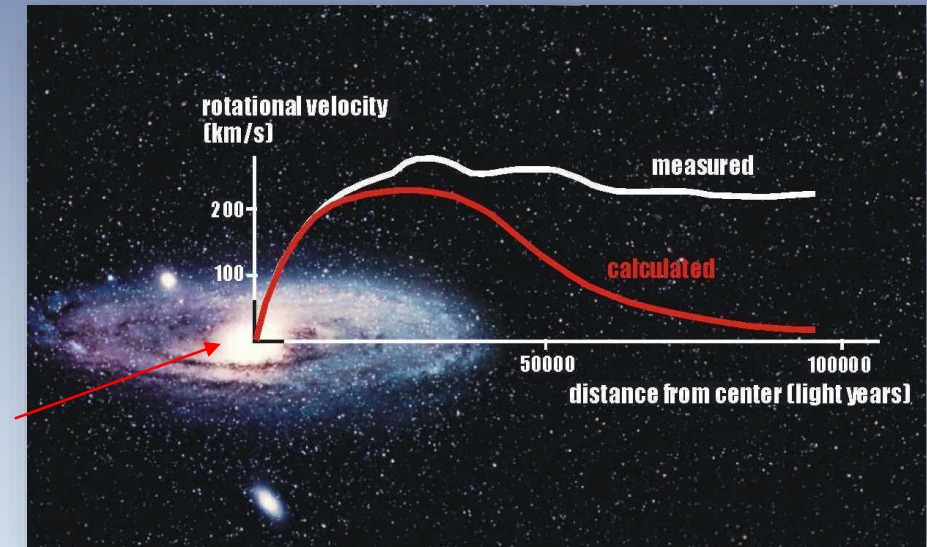
Dark Matter And Stellar Evolution Path



<https://www.britannica.com/science/star-astronomy/Star-formation-and-evolution>

- Dark matter (DM) ambient density maybe large
- DM collapse together with the molecular cloud
- Stars evolved with a DM core to become WDs

- Low mass stars end up as WDs
- WDs may evolve as supernovae



<https://phys.org/news/2011-12-dark.html>

What would DM admixture do to WDs and Type Ia Supernovae (SNeIa)?

Numerical Simulations In 1D

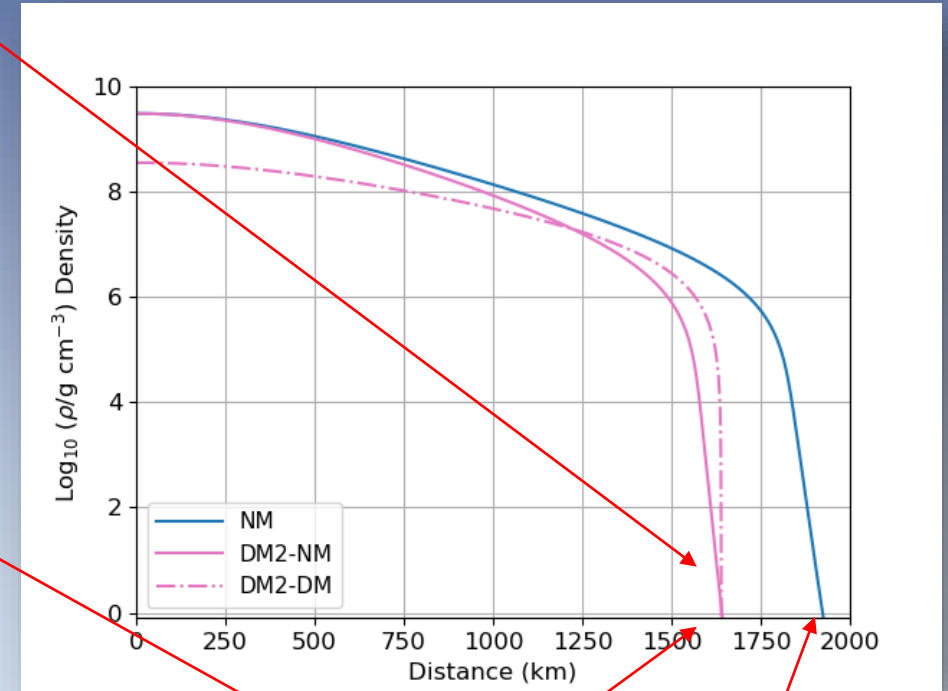
Progenitors - Dark Matter Admixed White Dwarfs

- Light DM particle mass ~ 0.1 GeV
- DM **is extended and comparable** to the NM

Model	NM	DM-1	DM0	DM1	DM2	DM3
NM ρ_c (10^9 g cm $^{-3}$)	3.0	3.0	3.0	3.0	3.0	3.0
DM Mass (M_\odot)	-	0.067	0.120	0.201	0.322	0.494
NM Mass (M_\odot)	1.374	1.242	1.183	1.124	1.067	1.015
DM Radius (km)	-	975	1160	1380	1640	1920
NM Radius (km)	1930	1890	1830	1740	1650	1560

Stellar Parameters For Supernova Progenitors

Density Profiles



NM Mass And
Radius Reduced

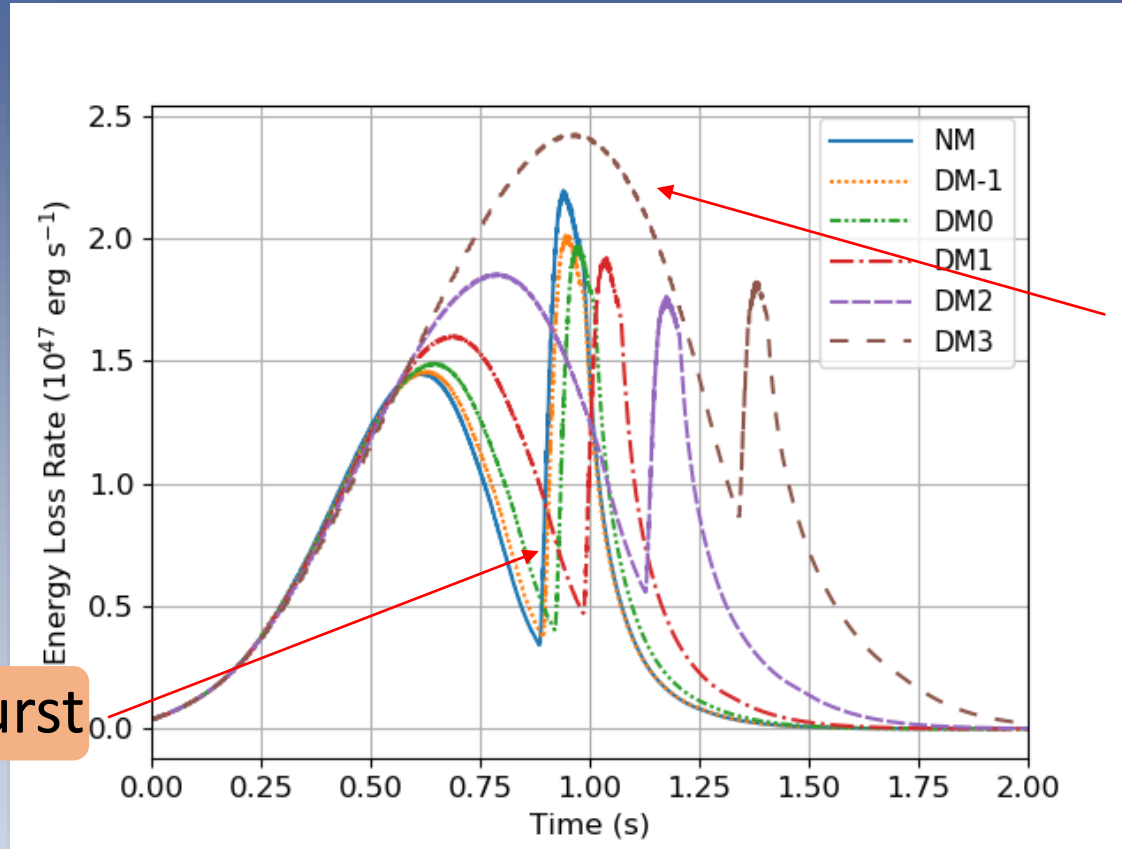
- They are used as progenitors for simulating DM-SNela
- Chan+ arXiv:2012.06857, Accepted By ApJ

Supernova Neutrinos

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Packages provided by
<http://cococubed.com/>



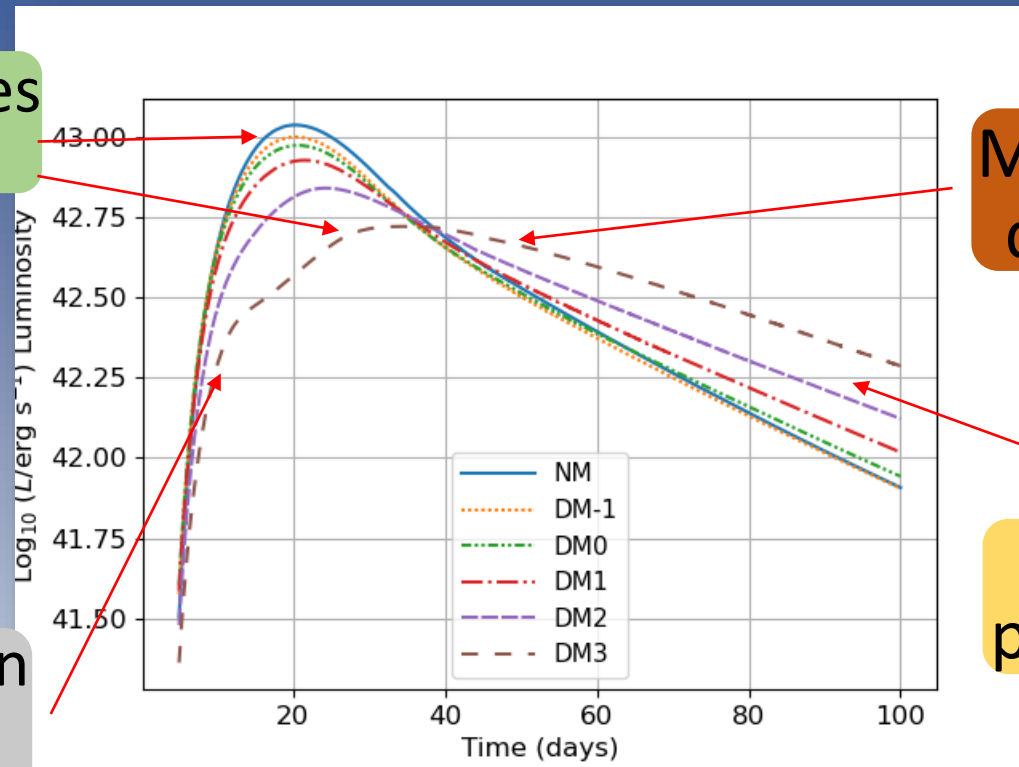
Neutrino Burst

More DM Results In More
Neutrino Production

- More neutrino produced for more DM admixtures
- Weaker neutrino burst – But overall, more ν production

Supernova Light Curves

Peak magnitudes
are similar



More DM then
decay slower

Brighter at
post-maximum

More DM then
rise slower

Dimmer and broader light curves!

- DM-admixed SNeIas produce unusual light curves
- They correspond to peculiar supernovae – **Examples?**

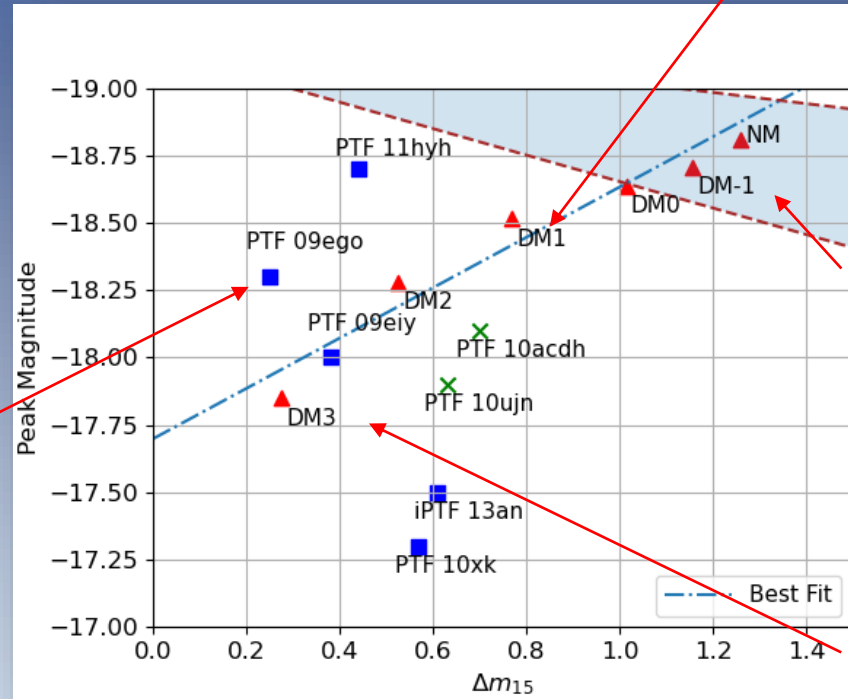
Computed by
the SNEC code

Observed Light Curves

- Interested in the **Peak Magnitudes vs Δm_{15}**

Orthogonal trend to the Phillips relation

Observed data through PTF



Observed R-Band usual Phillips relation
Used as standard candle in cosmology

Parameter spaces unreachable by varying progenitors or explosive mechanisms

- Peculiar supernovae have been observed
- Broad and dim light curves**
- DM models also produce dim and broad light curves!
- Help **provide alternative explanations to peculiar events**

Summary

- We simulated one-dimensional DM-admixed SNeIa
- DM is extended and have comparable sizes and masses to the NM
- DM-SNeIa has a weaker neutrino burst but generates more neutrinos
- DM-SNeIa produces broader and dimmer light curves
- Some peculiar supernovae could be explained by having a DM admixture

Thank You!

Welcome to contact
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Appendix

The Delayed Detonation Model

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- SNeIa – Explosion of a WD (standard candle in cosmology)
- Explosive modes classified as deflagrations or detonations



<https://www.xpproducts.com/blog/what-is-deflagration-venting>

Deflagration



<https://www.sutori.com/story/kaho-olawe--3kMhS5YL1RKWWLY7gNX74Ph5>

Detonation

- Sub-sonic heat conduction
- Super-sonic compression wave
- The **d**elayed **d**etonation (DDT) model is an explosion model of SNeIa
- A Detonation is generated after the passage of a deflagration

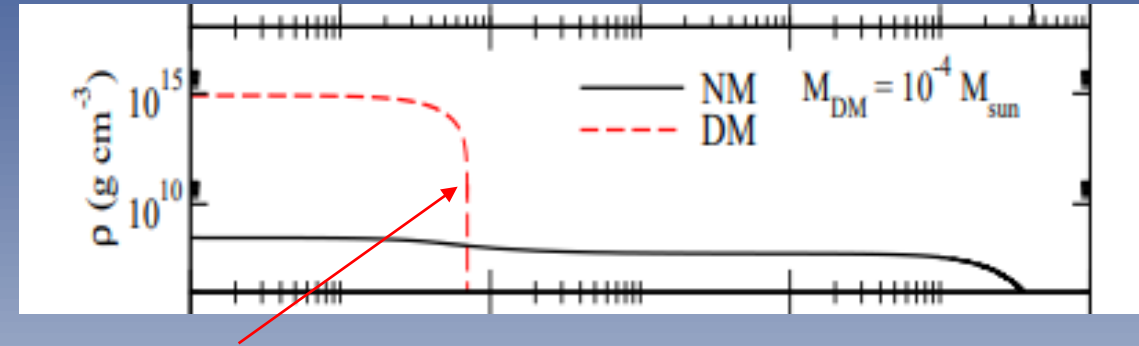
We study one-dimensional DM-SNeIa using the DDT model

Dark Matter Admixed White Dwarfs

- Assumed ideal degenerate Fermi gas for DM

Density Profiles

$$\frac{dp_i}{dr} = -\frac{G(m_1 + m_2)\rho_i}{r^2},$$
$$\frac{dm_i}{dr} = 4\pi r^2 \rho_i.$$



Compact DM

- The index $i = 1(\text{DM})$ and $2(\text{NM})$
- Can be generalize to GR (TOV)
- Leung (2013) assumed DM particle mass larger than 1 GeV
- Explode with PTD model – Explain some Type Ia

How about other model (DDT) for an extended DM component?