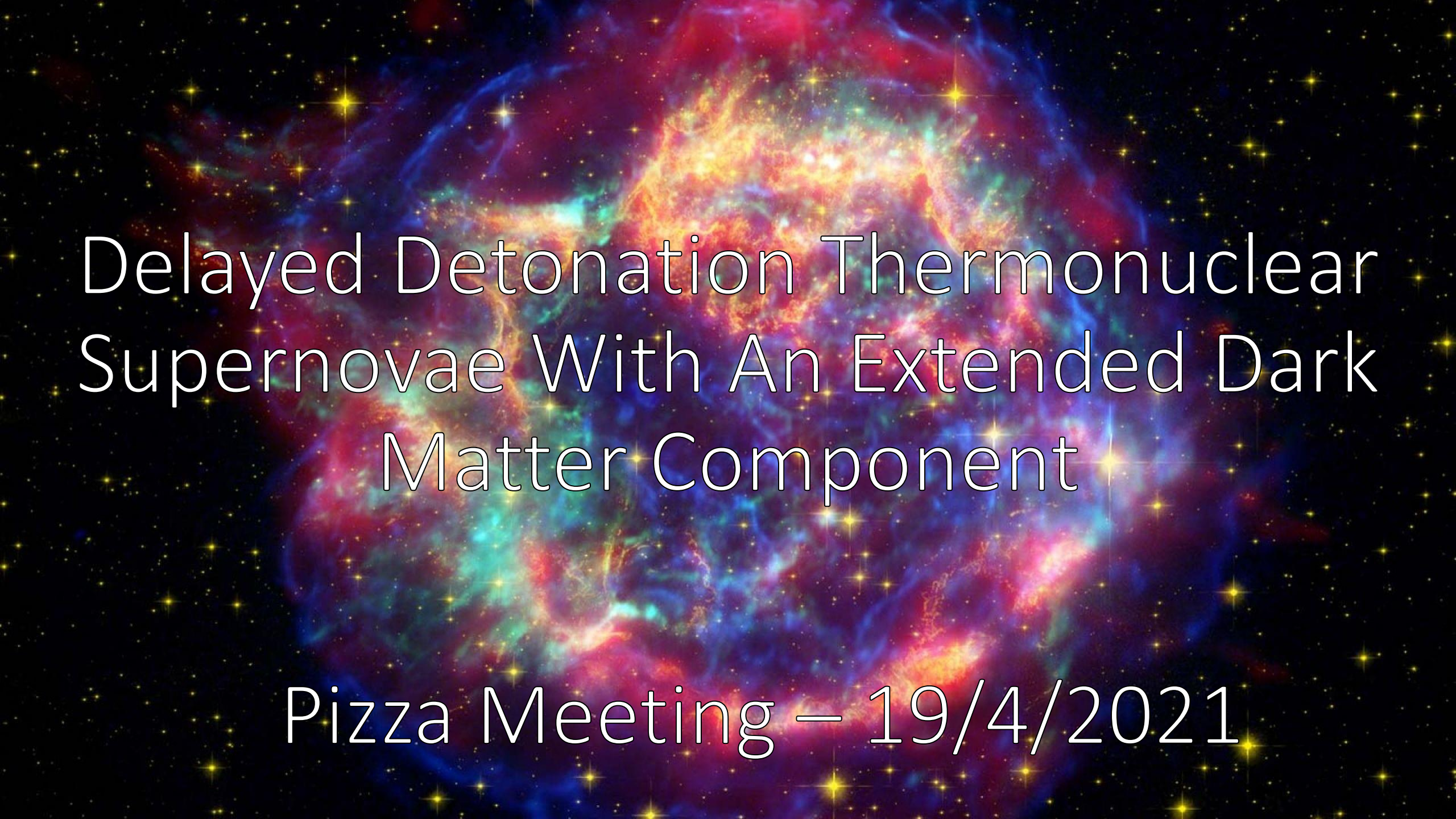

Delayed Detonation Thermonuclear Supernovae With An Extended Dark Matter Component

Pizza Meeting – 19/4/2021

Self-Introduction

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Prof. M-C. Chu

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Me

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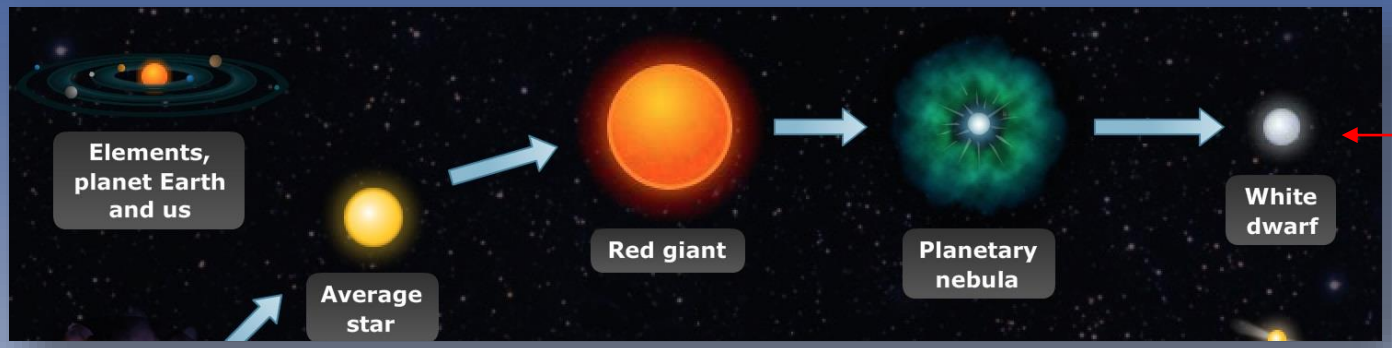
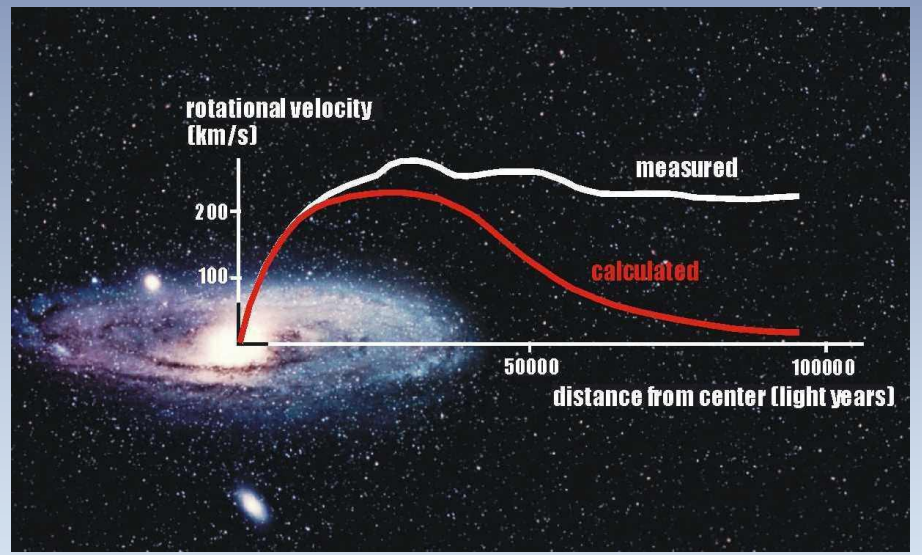
Dark Matter And Stellar Evolution Path



- Low mass star end up as WDs
- WDs may undergo supernovae



- Dark matter ambient density maybe large
- Dark matter particles “captured” by stars
- Stars evolved with a DM core to WDs

What would DM admixture do to WDs and SNeIa?

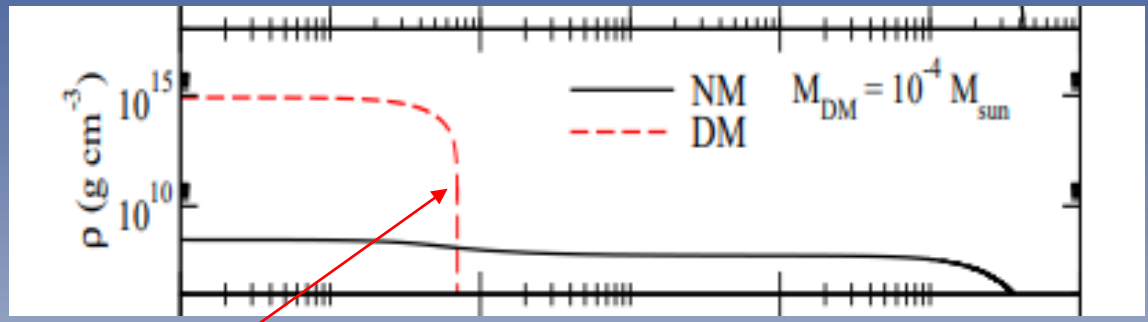
Dark Matter Admixed White Dwarfs

- Assumed ideal degenerate Fermi gas for DM

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

$$\frac{dm_i}{dr} = 4\pi r^2 \rho_i.$$

Density Profiles



Compact DM

- The index i = 1(DM) and 2(NM)
- Can be generalize to GR (TOV)

- Leung (2013) assumed DM particle mass larger than 1 GeV
- Explode with PTD model – Explain some Type Iax

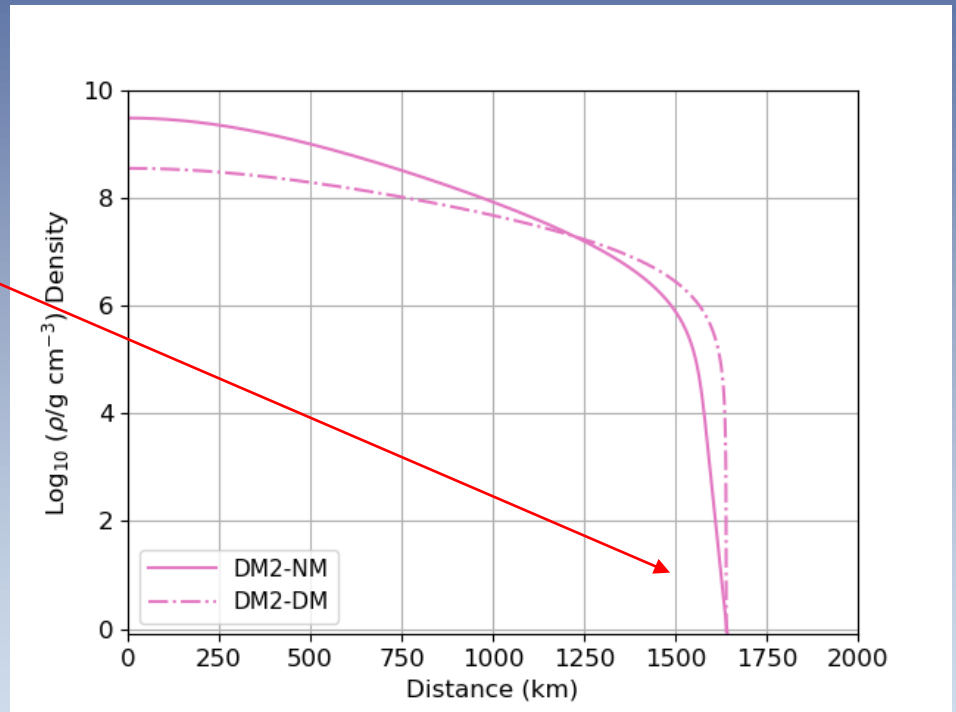
How about other model (DDT) for an extended DM component?

Dark Matter Admixed White Dwarfs

- Lighter DM particle - 0.1 GeV
- DM is extended and comparable to 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

Density Profiles



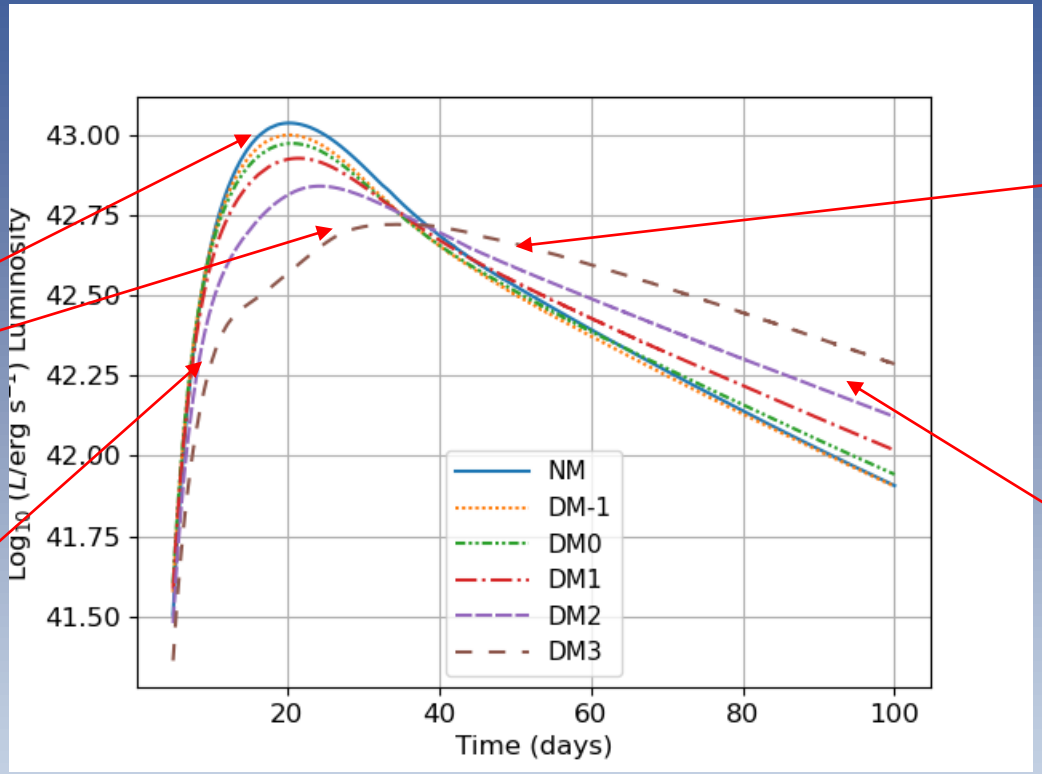
- Used as progenitors for DM SNeIa
- Chan+ arXiv:2012.06857, submitted to ApJ

Supernova Light-curves

Computed by
1D-DDT + SNEC

Peak magnitudes are similar

More DM rising slower



More DM decaying slower

Brighter at post-maximum

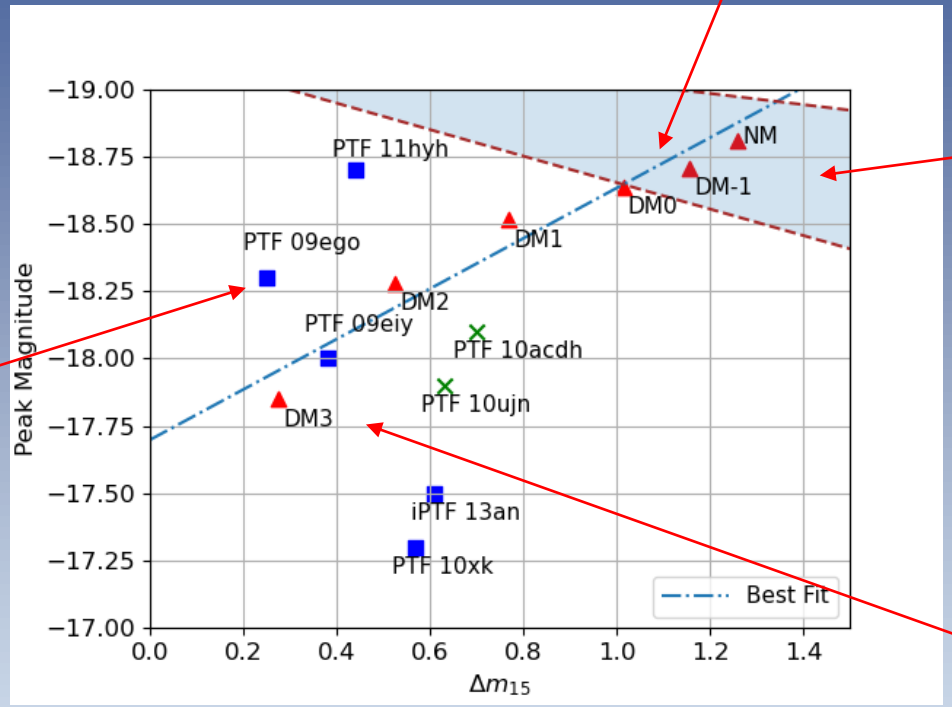
Dimmer and broader light curves

- DM-admixed SNeIa produced unusual light-curves
- Corresponds to peculiar supernovae – Examples?

Observed Light Curves

- Interested in the Peak Magnitudes vs Δ_{m15}

Orthogonal trend to Phillips relation



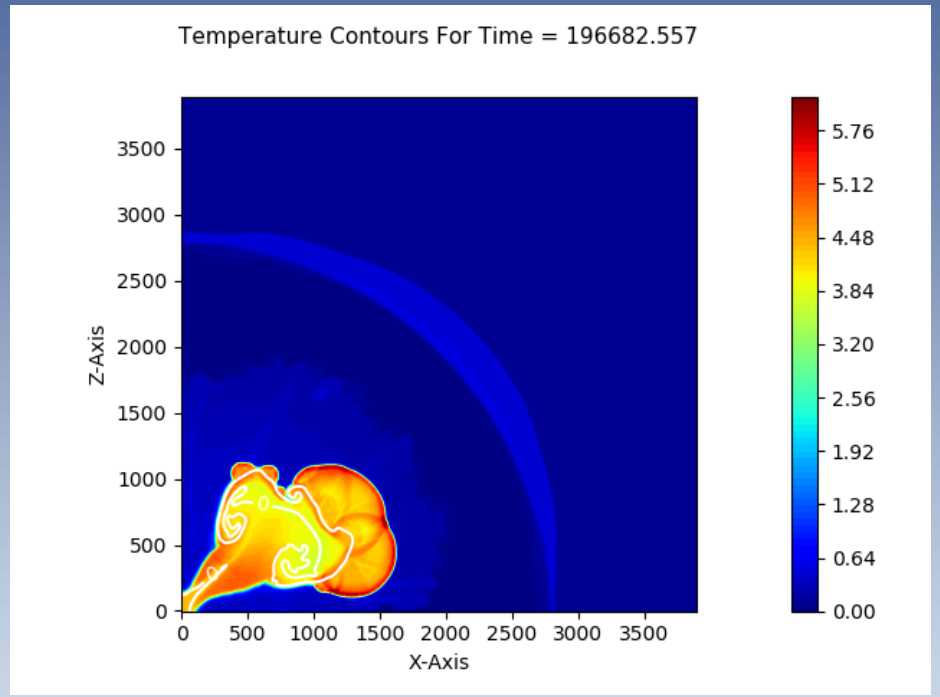
Observed R-Band Phillips relation

Observed data using PTF

Parameter spaces unreachable by varying progenitors or explosive mechanisms

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

Current Projects – Higher Dimension

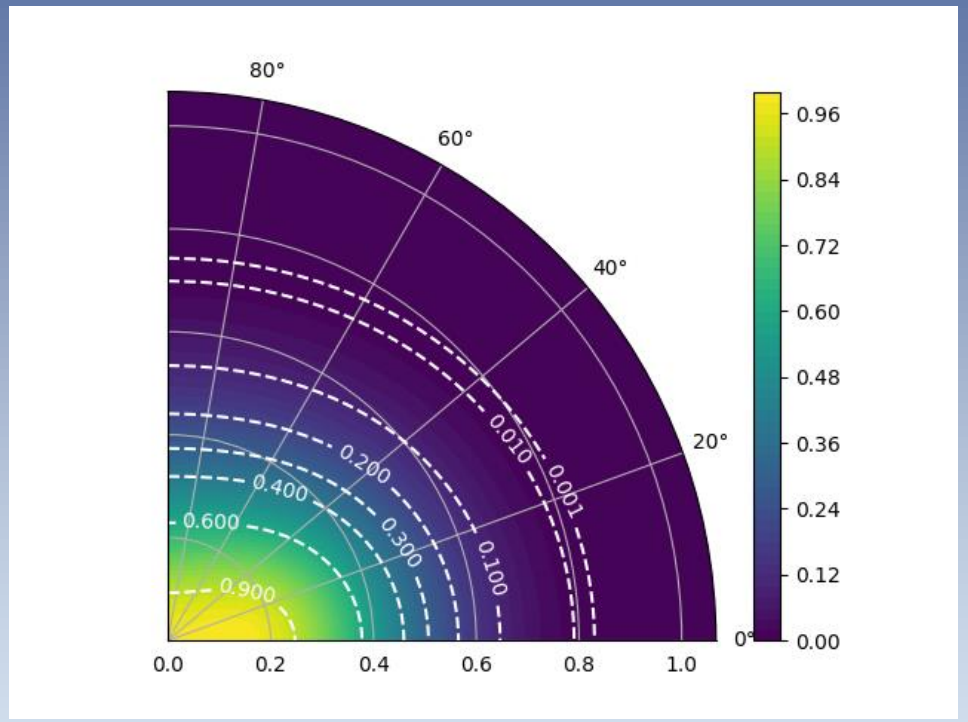


2D DM-admixed SNeIa

Turbulence …

Nucleosynthesis …

DM-admixed rotating WDs



DM structure reacted to A flattened rotating NM