Nebular phase NIR spectra of the sibling SN 2013aa and SN 2017cbv

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Massive Stars and Supernovae 2018
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Two SN Ia in the same Host Galaxy: NGC 5643

Nebular phase FIRE Spectra

SN 2013aa

+368	2014-02-22
+428	2014-04-23
+506	2014-07-10

SN 2017cbv

+311	2018-01-31
+436	2018-06-05
+512	2018-08-20

Nebular phase FIRE Spectra

SN 2013aa

+368	2014-02-22
★ +428	2014-04-23
★ +506	2014-07-10

SN 2017cbv

★ +311	2018-01-31
★ +436	2018-06-05
+512	2018-08-20

Thank you Nidia!

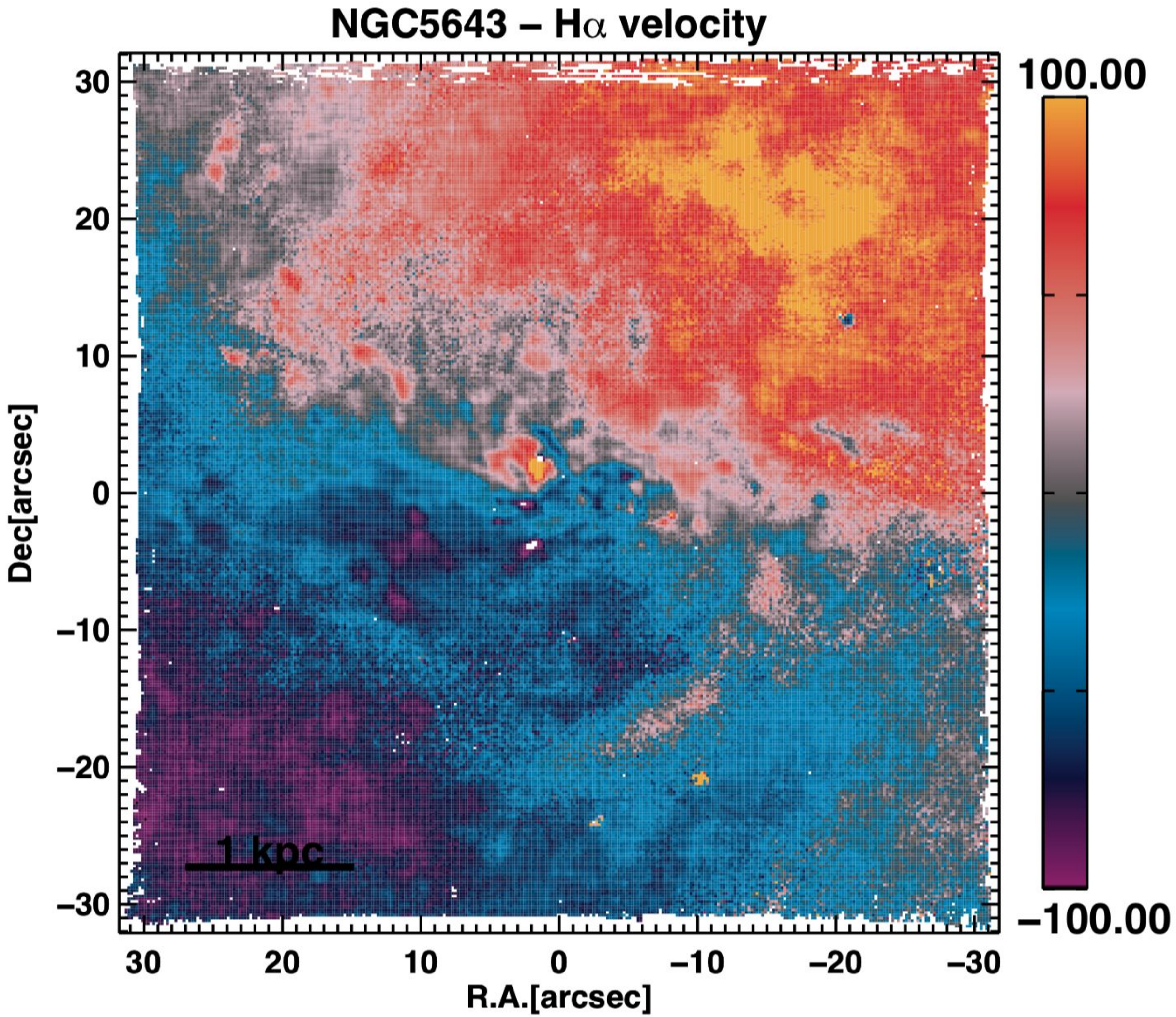
SN	Phase	Central Wavelength (Å) of [Fe II] 1.644 μm line	Velocity Shift (km/s)
SN 2017cbv	+311	16462.6747 +/- 4.8	413.20 +/- 87.397
SN 2017cbv	+436	16455.5019 +/- 6.4	282.55 +/- 116.57
SN 2017cbv	+512	16463.5759 +/- 6.27	429.61 +/- 114.15
SN 2013aa	+368	16421.9398 +/- 3.88	-329.518 +/- 70.8
SN 2013aa	+428	16435.2633 +/- 3.99	-86.388 +/- 72.77
SN 2013aa	+506	16436.6721 +/- 4.56	-60.69 +/- 83.159

2017cbv is redshifted, SN 2013aa is slightly blueshifted

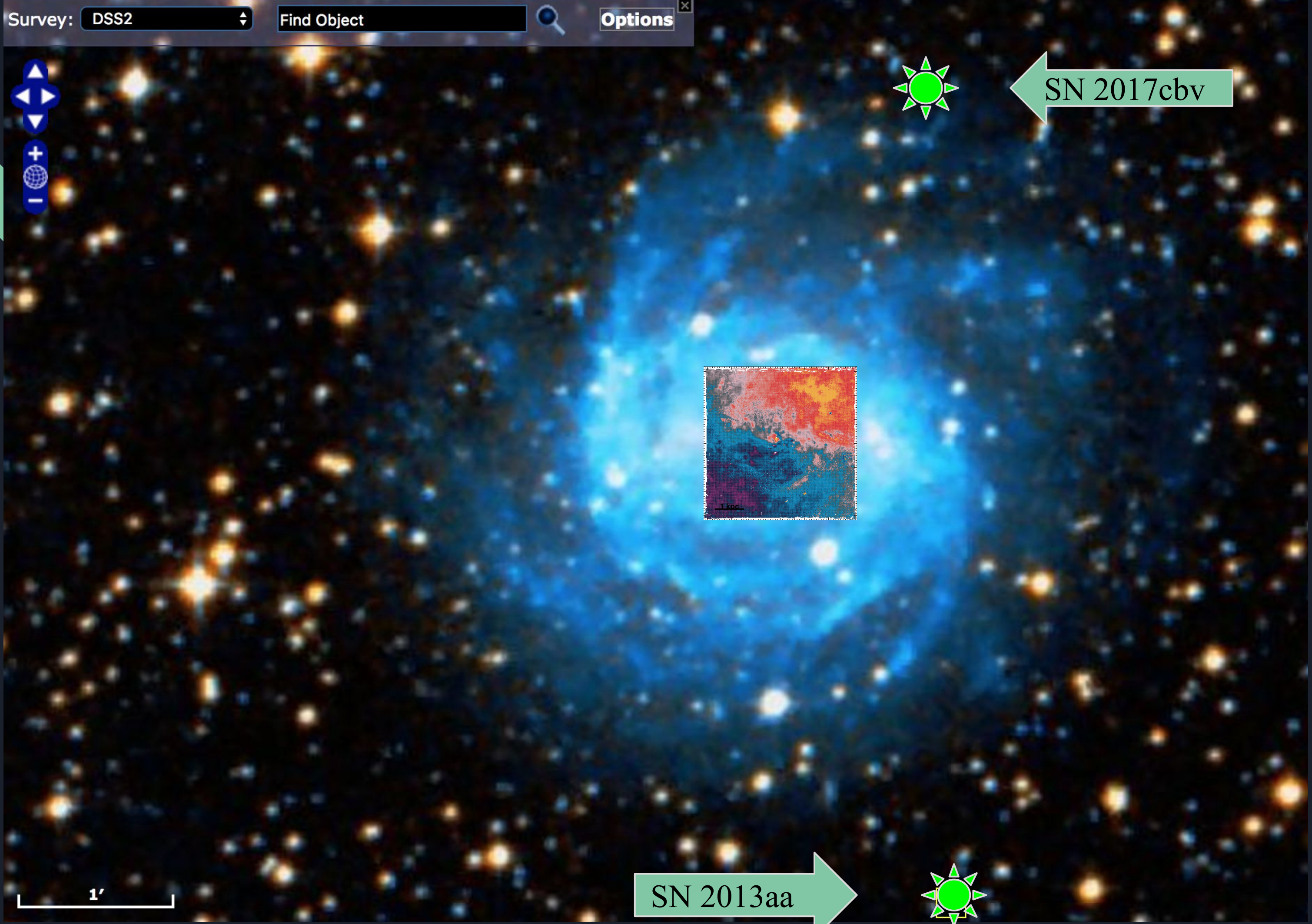
NGC 5643

SN 2013aa

SN 2017cbv



AMUSING Hα map of NGC 5643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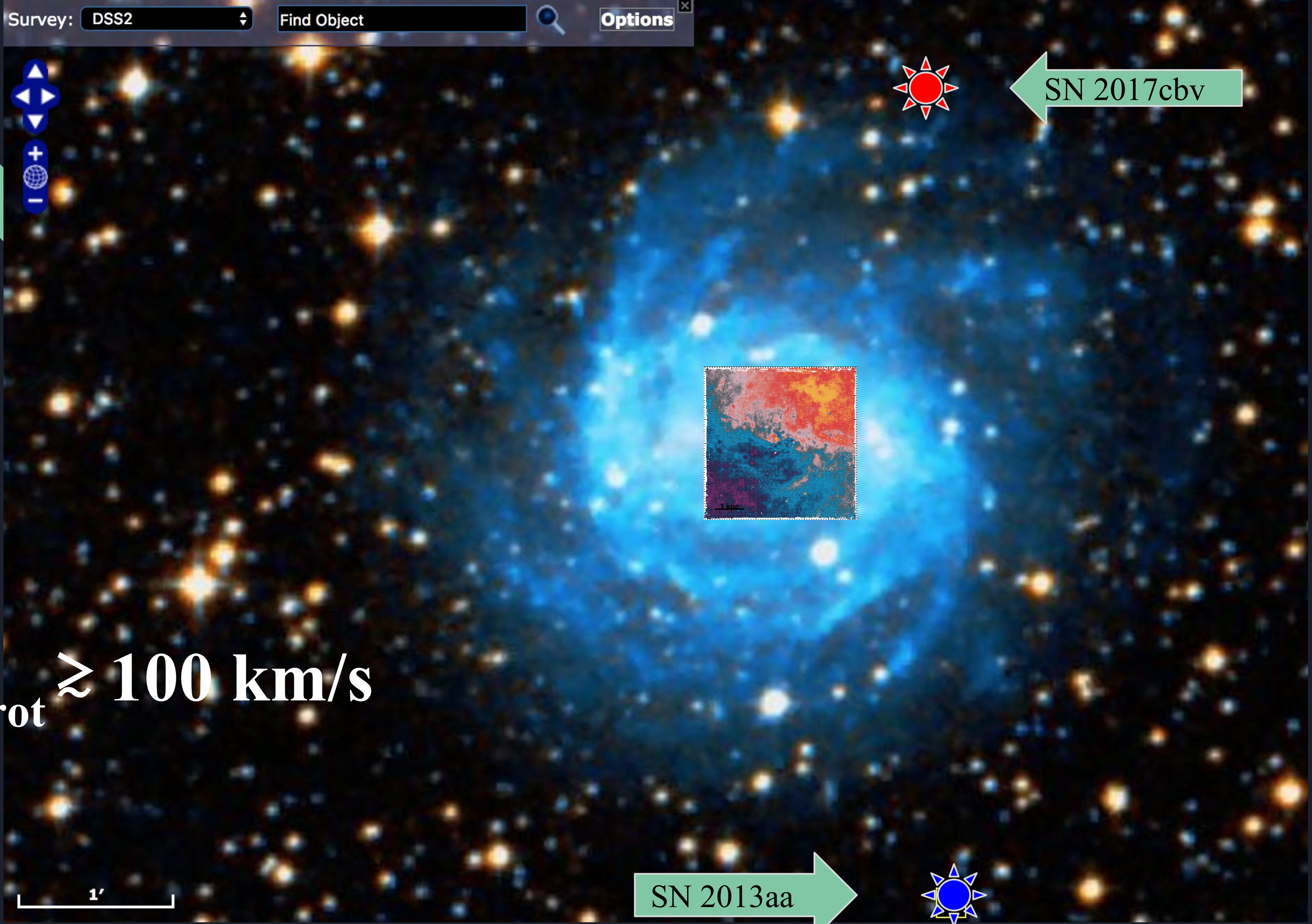
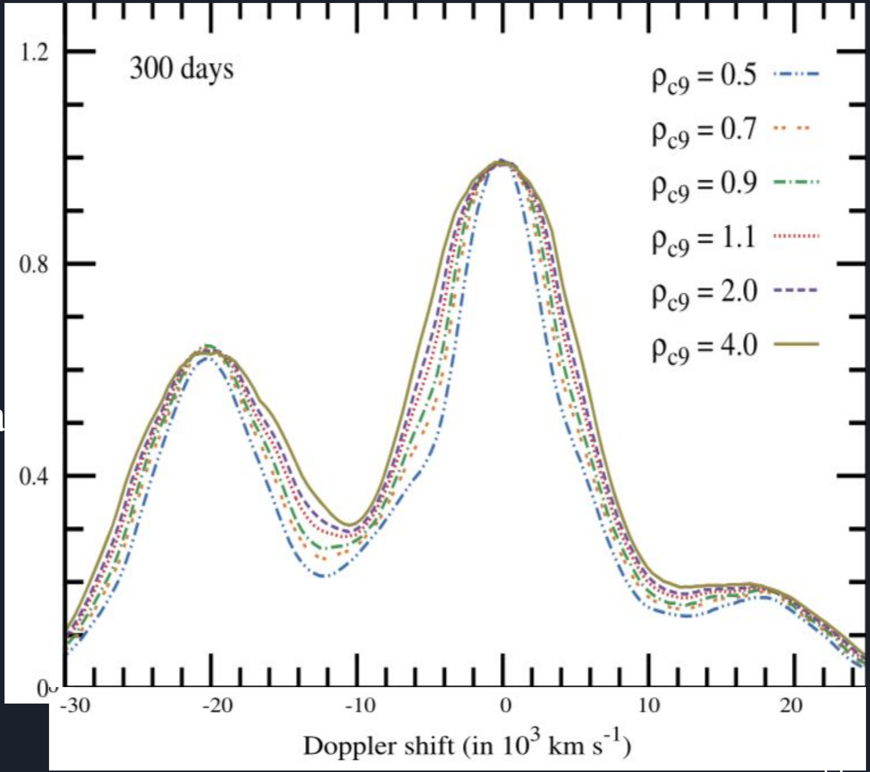
Find Object
Options
SN 2017cbv
SN 2013aa
1′



$\Delta v_{rot} \gtrsim 100$ km/s

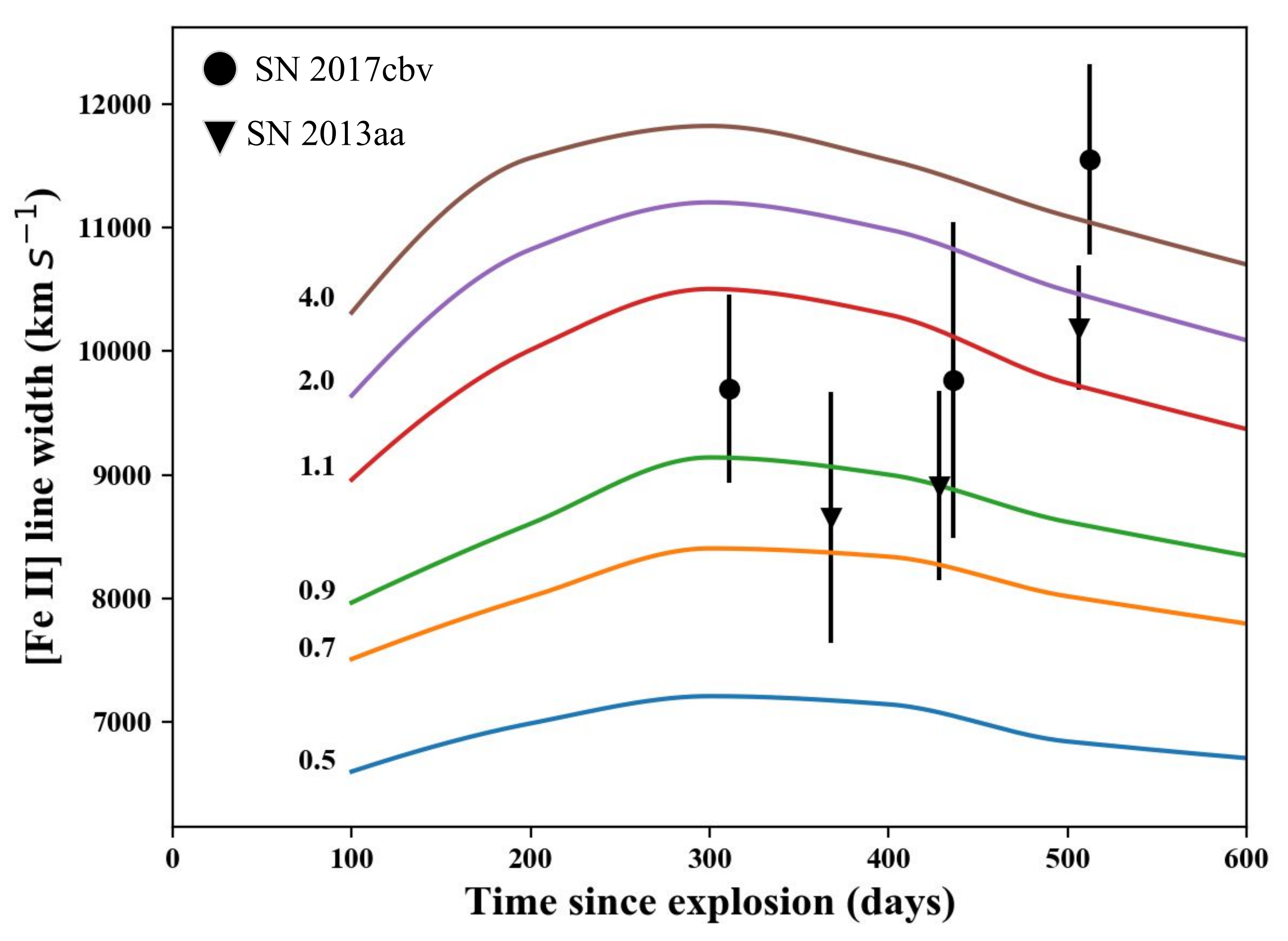
We can use the width of the [Fe II] 1.644 micron line to probe WD central density

- WD central density affects the amount of electron capture during the deflagration phase, determining amount of stable IGEs produced
- Dominant source of energy deposition changes from gamma rays to positrons by 300 days
- High velocity positrons inject energy into ejecta surrounding stable iron in the central region, adding to width of emission feature
- Higher WD central density → Broader [Fe II] 1.644 micron line



Diamond et al. 2015

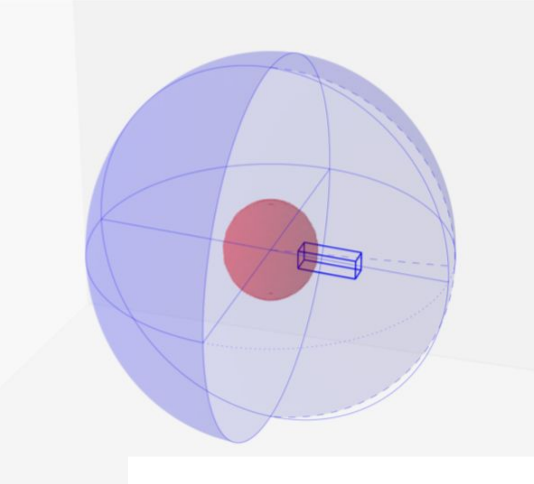
Comparison to DDT models



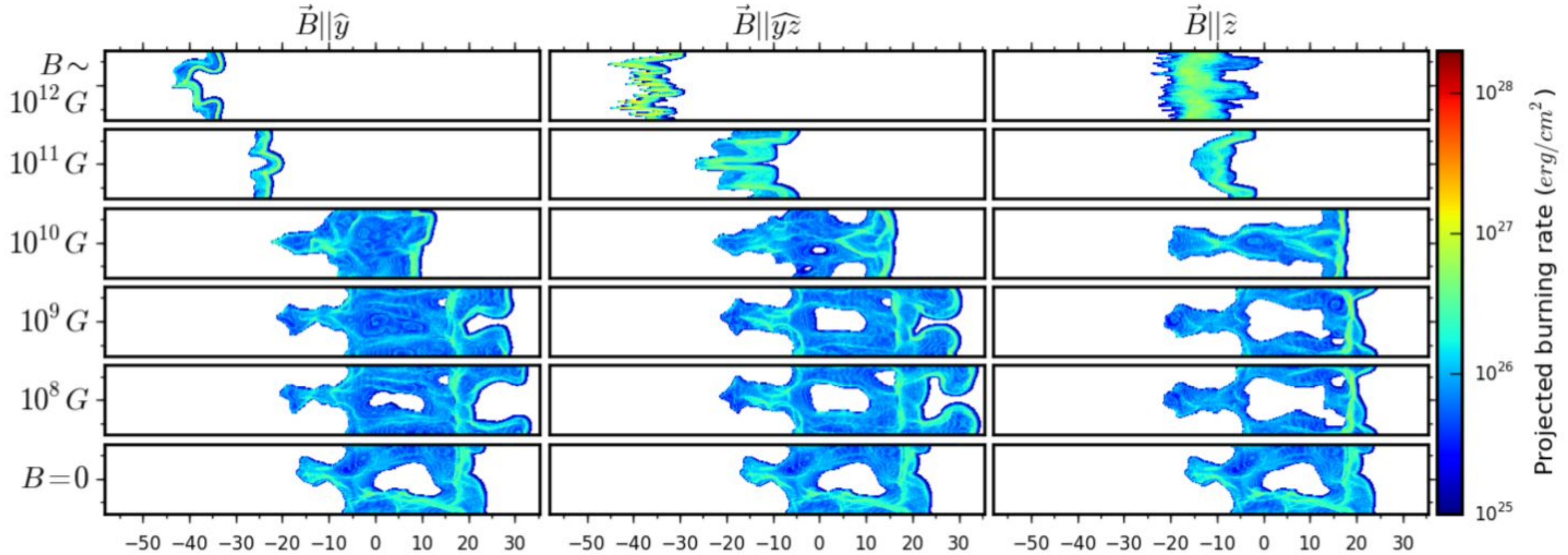
Diamond et al. 2015
Diamond et al. 2018
Hoeflich et al. 2017

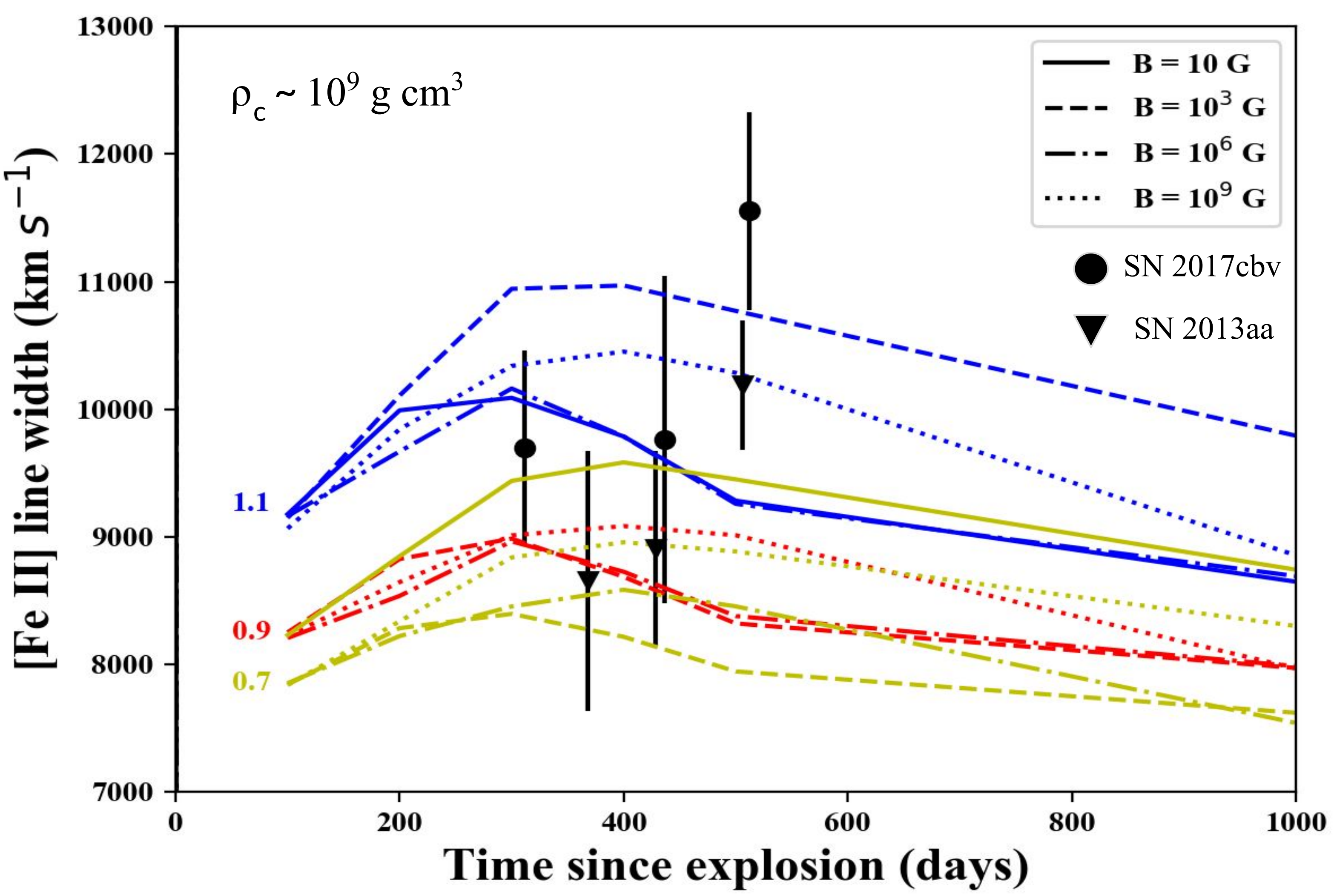
$\rho_c \sim 10^9$ g cm^3

Probing WD central density with [Fe II] 1.644 μm line width

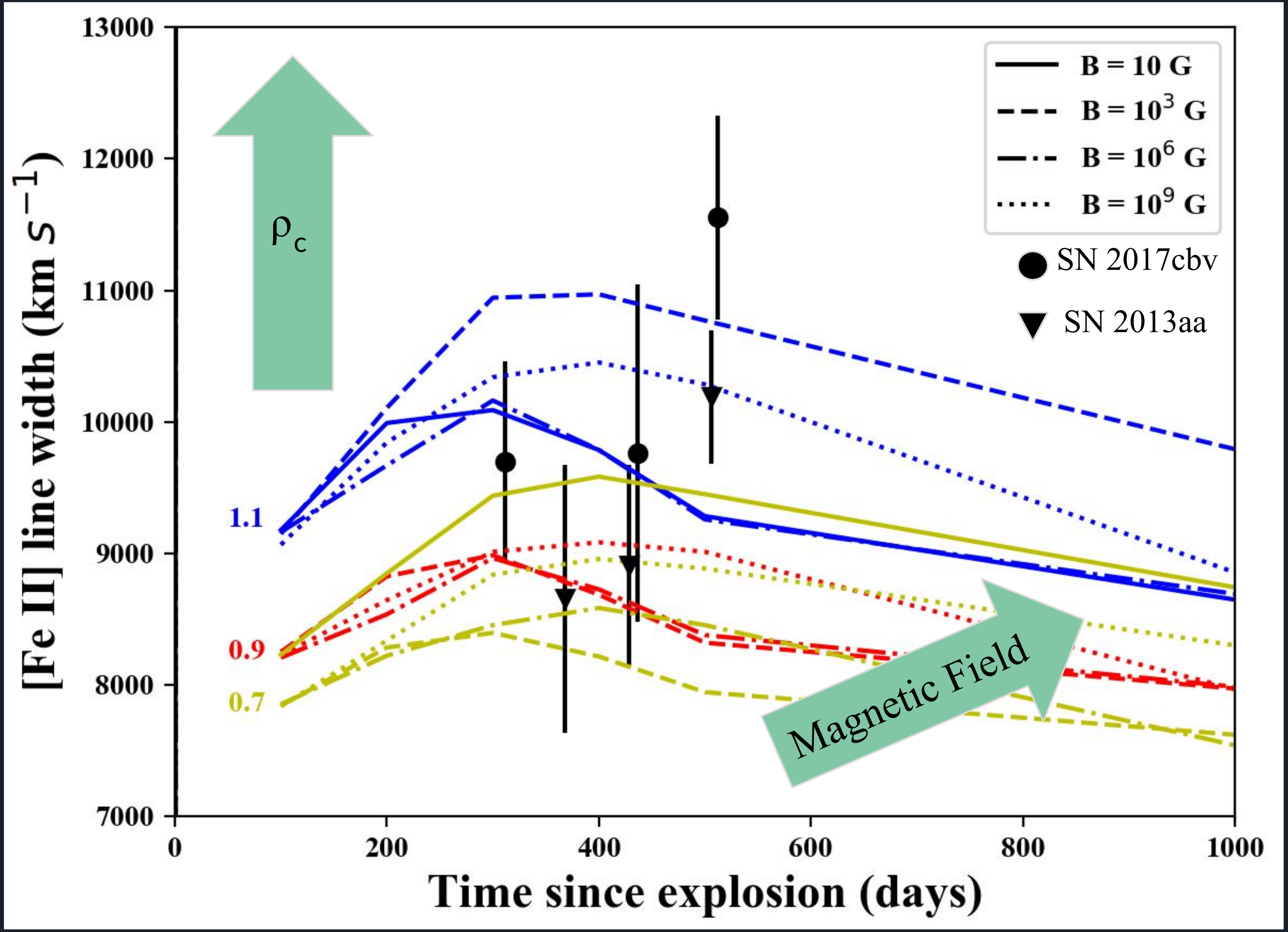


High magnetic fields can address RT instabilities and suppress mixing (Hristov et al. 2018)





ρc ~ 10^9 g cm^3
B = 10 G
B = 10^3 G
B = 10^6 G
B = 10^9 G
SN 2017cbv
SN 2013aa
1.1
0.9
0.7
[Fe II] line width (km s^−1)
Time since explosion (days)
13000
12000
11000
10000
9000
8000
7000
0
200
400
600
800
1000



13000
12000
11000
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[Fe II] line width (km s^{-1})
Time since explosion (days)
B = 10 G
B = 10^3 G
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SN 2017cbv
SN 2013aa
ρ_c
Magnetic Field
1.1
0.9
0.7

Conclusion

- Two SN Ia in the same host galaxy is an opportunity to explore intrinsic SN Ia diversity
- Correcting line velocities at nebular phases for galaxy rotation
- [Fe II] 1.644 μm line probes progenitor WD central density
- Broad [Fe II] 1.644 μm lines may indicate strong B fields