Comparing lightcurves of SN2014J to SN1987A between cooling phase and Nickel-56 peak

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1 Abstract

When a supernova explodes, the matter of the star is ripped apart with such force that even neutrons are ripped from protons. As the expanding cloud cools, the matter forms into ^{56}Ni, a relatively stable atom. ^{56}Ni decays over time into ^{56}Co, then ^{56}Fe. Each of step of this decay process releases gamma rays, which deposit energy into the surrounging gas, "propping up" the supernova's luminosity.

Preceding the peak of ^{56}Ni and thus luminosity in the supernova and after the drop in luminosity due to cooling, Type Ia supernovae like SN2014J and Type II-P supernovae like 1987A differ significantly. Here we compare example lightcurves from each category and discuss implications for how the supernovae explode and how we decide taxonomy.

2 Background and Data

Since oldest living memory, the dungeon has lived in the heart of the old wood.

3 Type Ia Example: 2014J

The mechanisms of Type Ia supernovae are, like most other supernovae, only gestured at by modern astrophysics; we can guess some of what happens, but the exact mechanisms of the explosion and progenitors remain mysterious. What we do know is that Type Ia lightcurves are remarkably consistent. They have the steepest climb to the ^{56}Ni plateau of all the types, post-cooling. We plot this range here for SN2014J: first band by band, then with all the bands compared together.

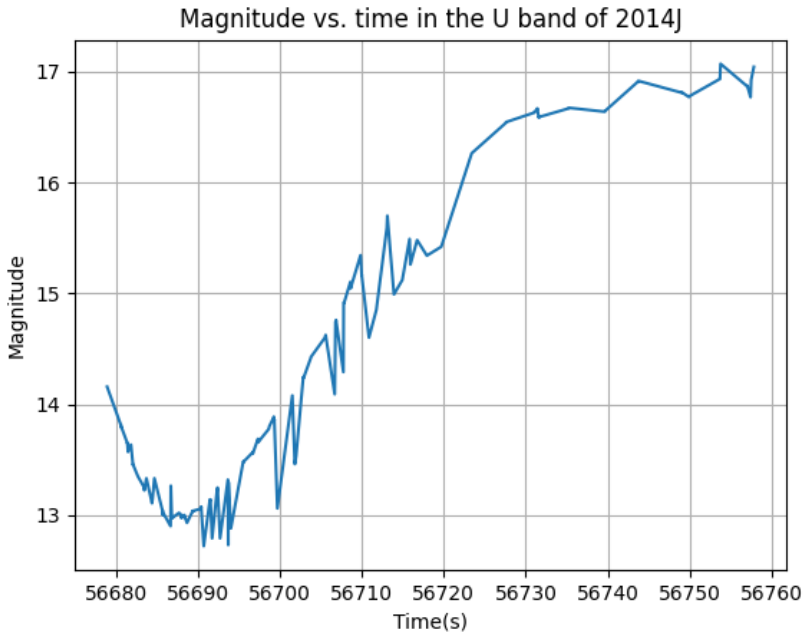

Figure 1: Change in brightness of SN2014J across time in the U band.

4 TypeII-b Example: 1987A

Type II-P supernovae starkly contrast with the quick rise-and-drop in magnitude of other supernovae before ^{56}Ni beta decay takes hold of the magnitude. Type II-L supernovae exhibit lightcurves very similar to those of Type Ias, but II-Ps show unusual slow rises and relatively flat plateaus that can stretch to 100 days or more. Here we plot magnitude versus time for five bands of 1987A, the quintessential Type II-P supernova, with special attention to its pre-plateau shape.

5 Lightcurve Comparison

6 Summary

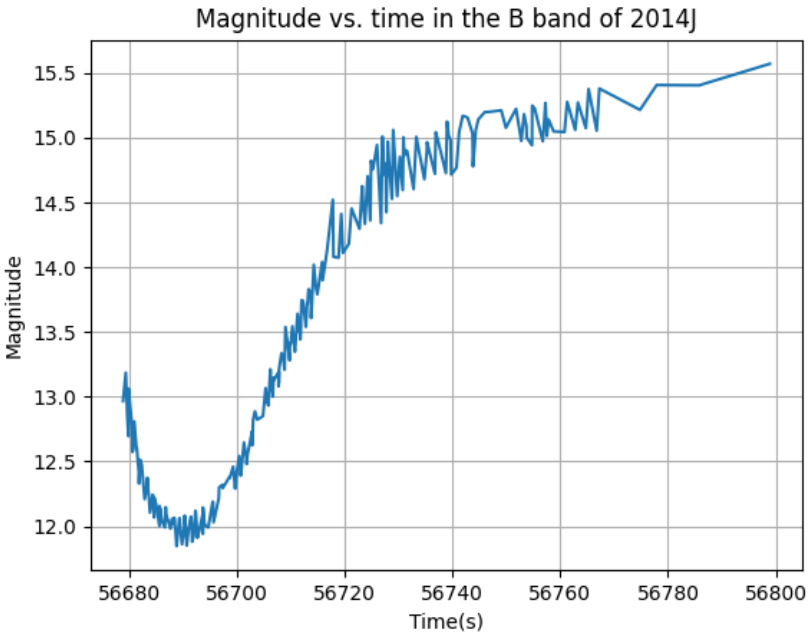

Figure 2: Change in brightness of SN2014J across time in the B band.

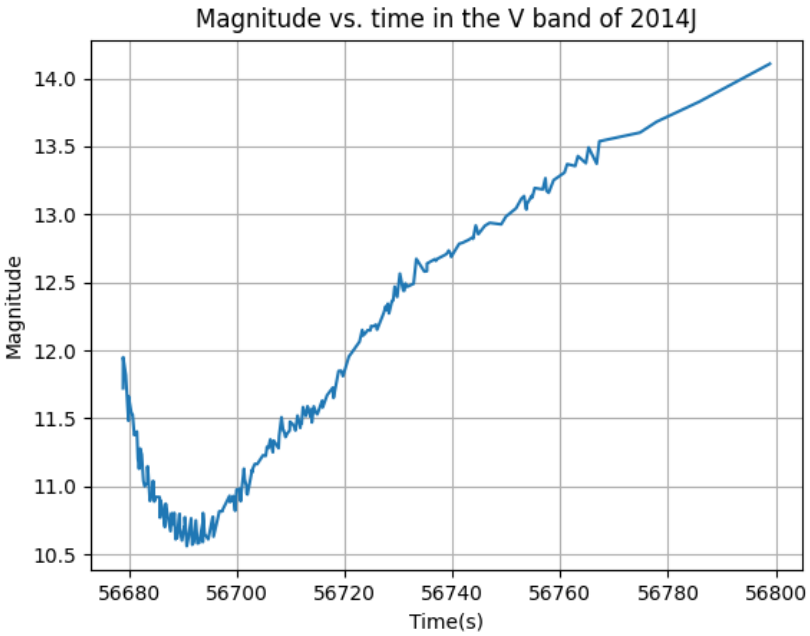

Figure 3: Change in brightness of SN2014J across time in the V band.

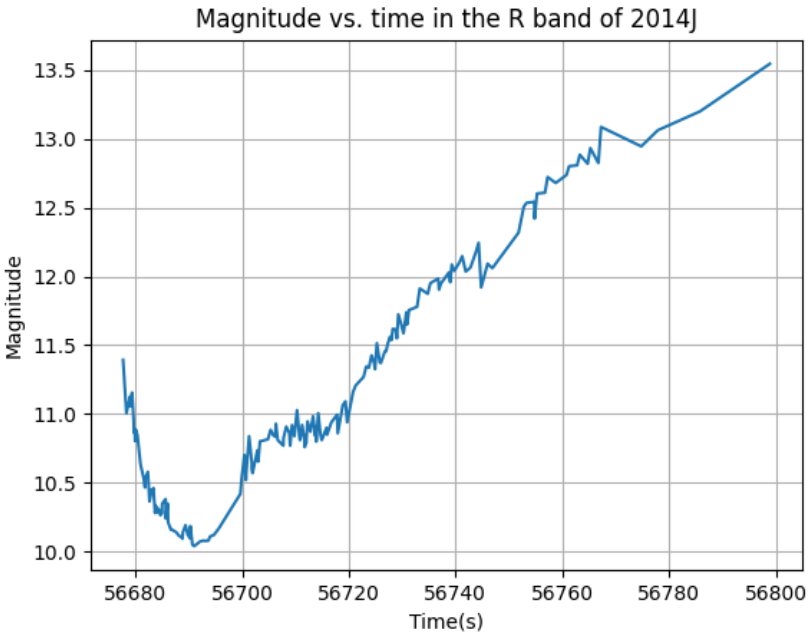

Figure 4: Change in brightness of SN2014J across time in the R band.

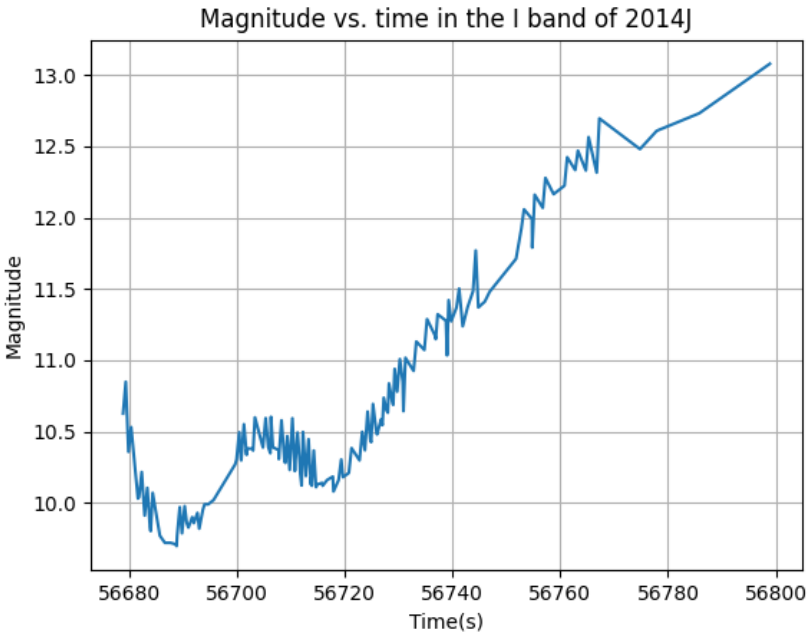

Figure 5: Change in brightness of SN2014J aross time in the I band.

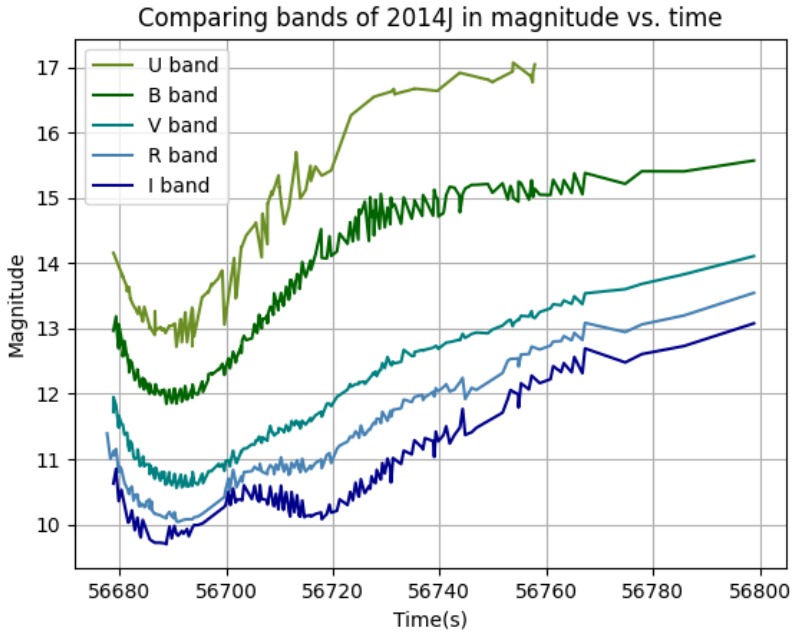

Figure 6: All bands of SN2014J together. Note especially the differences between the shape of the I band brightness over time compared to the bluer colors. Just before 56720 seconds, a "shoulder" is visible in the curve. Its beginnings show up in the R band as well.

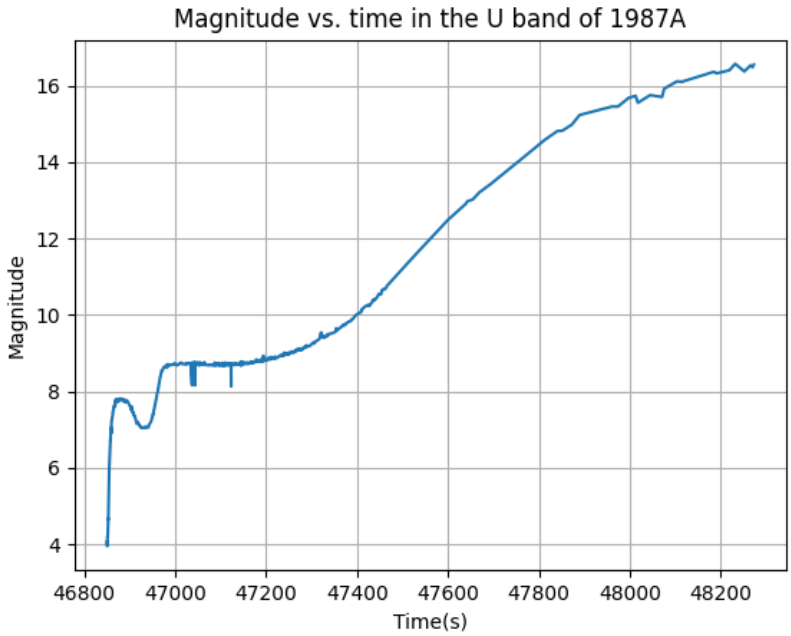

Figure 7: Change in brightness of SN1987A across time in the U band.

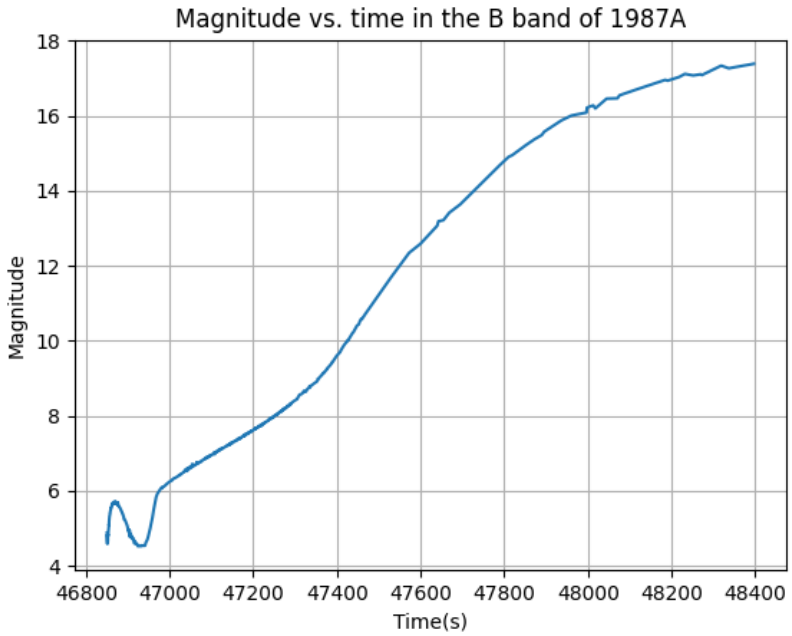

Figure 8: Change in brightness of SN1987A across time in the B band.

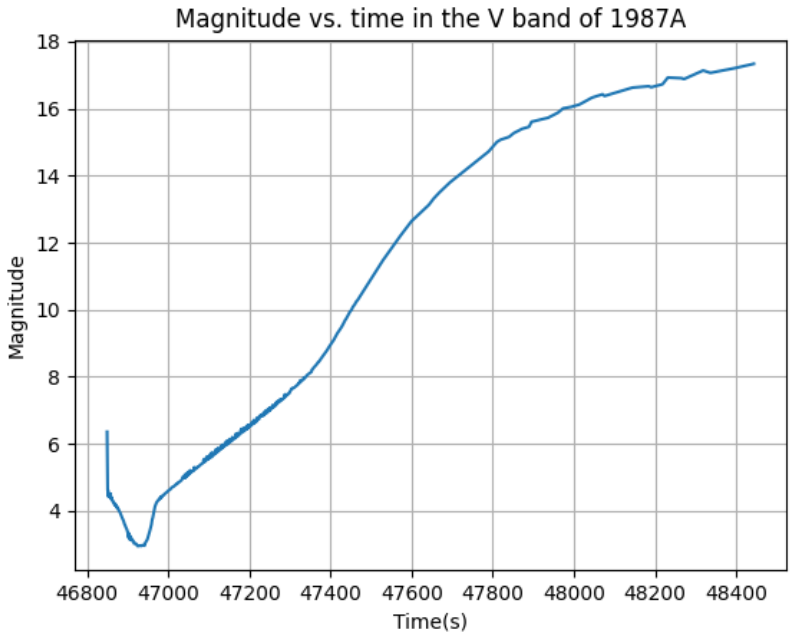

Figure 9: Change in brightness of SN1987A across time in the V band.

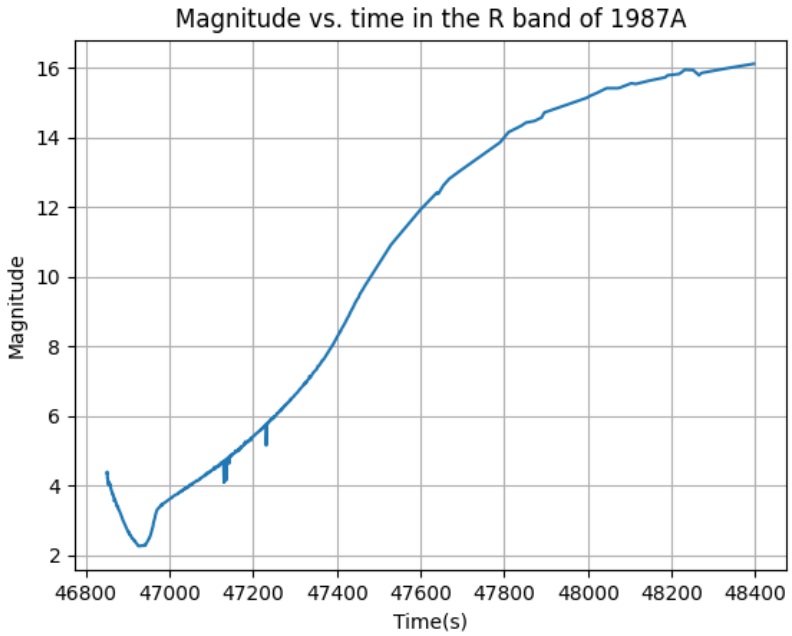

Figure 10: Change in brightness of SN1987A across time in the R band.

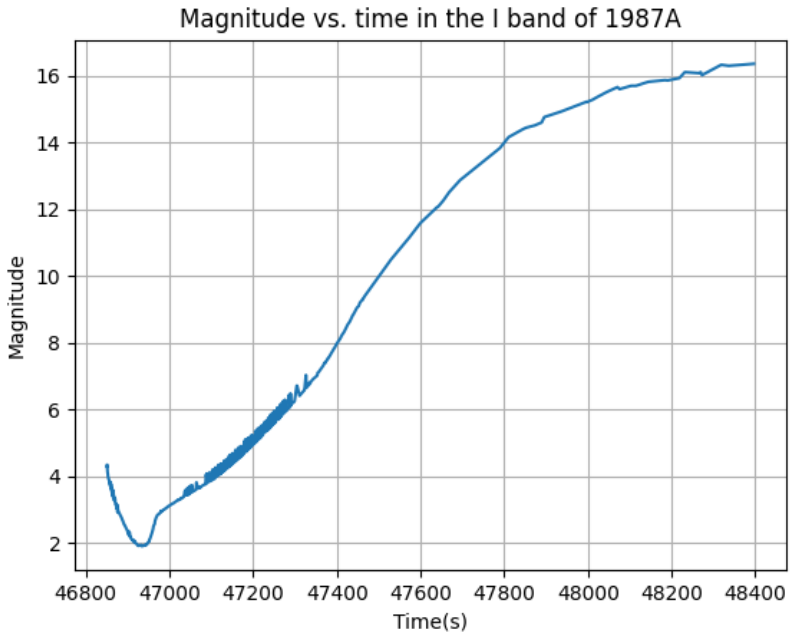

Figure 11: Change in brightness of SN1987A aross time in the I band.

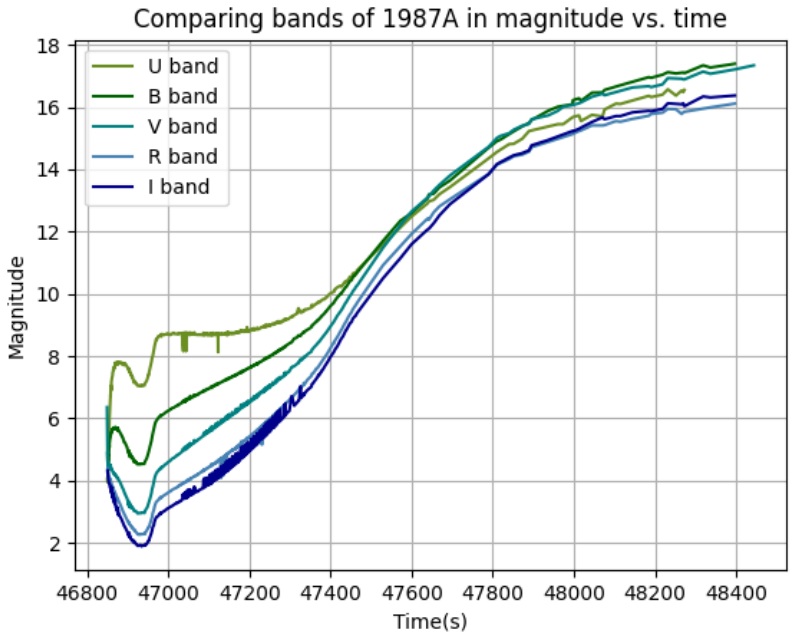

Figure 12: All bands of SN1987A together. Note the similarity in magnitude vs. time curve of each of the five bands, as opposed to the distinct differences between bands observed in 2014J.