FITTING THE SPECTRA OF SN2021FXY USING SYNOW

Sara Paugh

Mentors: Dr. Baron and James Derkacy

Overview

- Background on type Ia supernovae
- Basic information about SN2021fxy
- Why we care
- SYNOW
- Fit spectra
- Future progress

Background

- Type Ia supernovae are thermonuclear explosions that occur in binary systems in which at least one star is a white dwarf
- The white dwarf accretes matter from the expanding nondegenerate star in its system
- If both stars are white dwarfs, they will merge together
- White dwarf will approach Chandrasekhar mass (1.4 $M_\odot$)
- White dwarf contracts and heats up

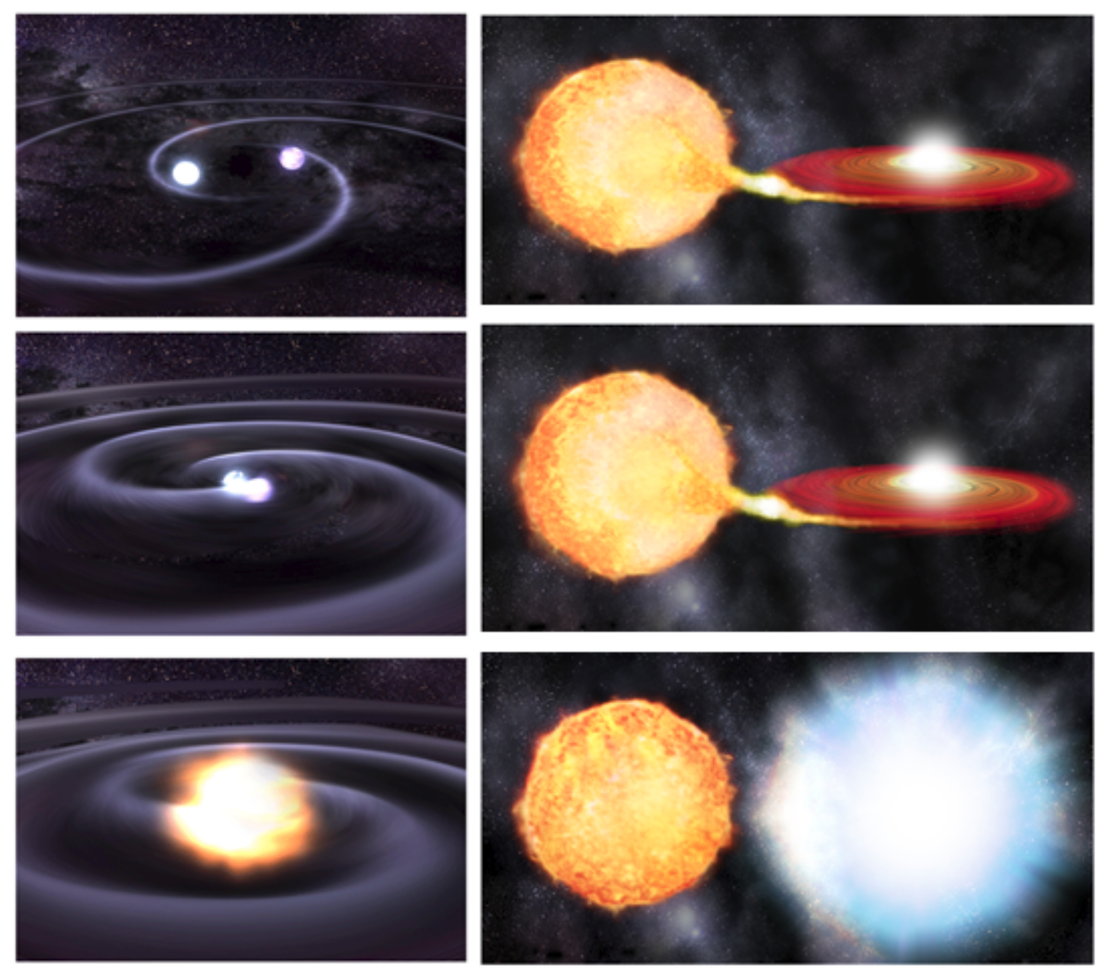
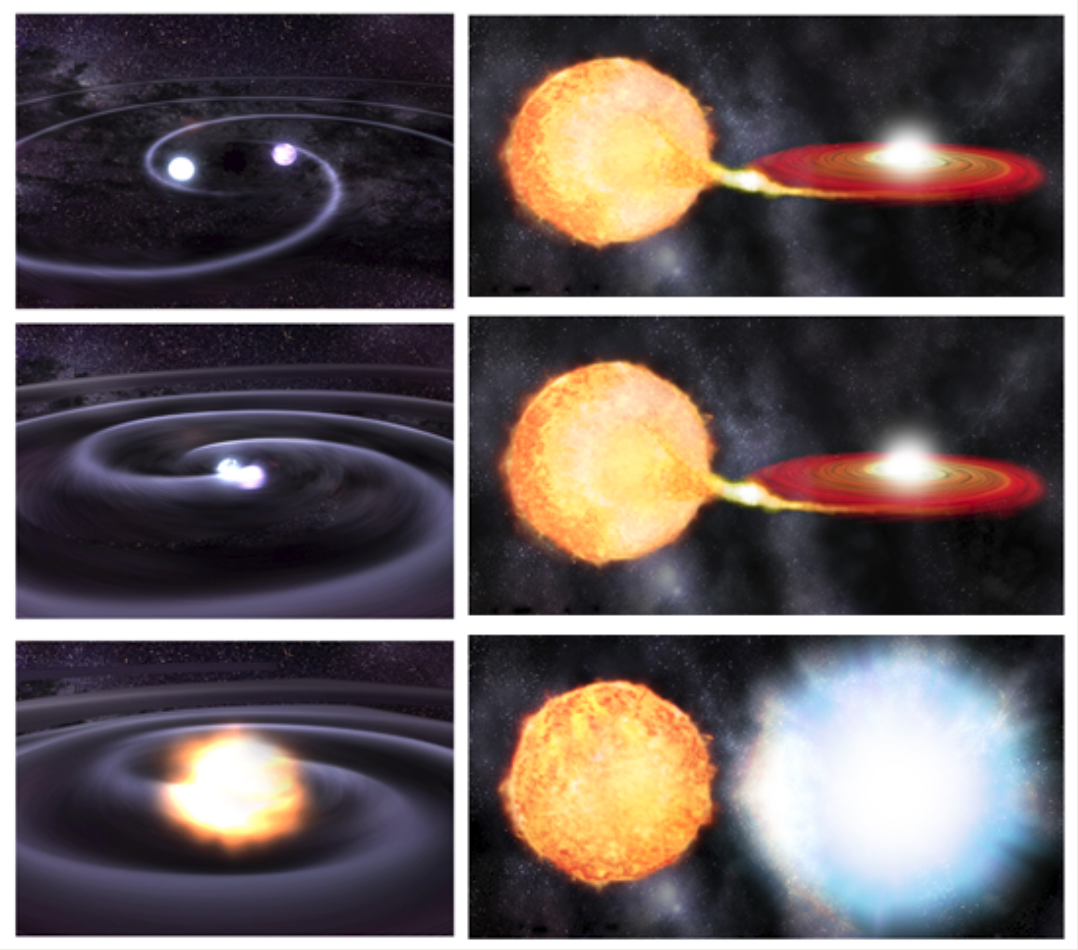


Image credit: Wikipedia Commons

Background

- Carbon and oxygen fuses into heavier elements
- Nuclear fusion releases enough energy for an explosion
- Inner layers primarily form ^{56}Ni (decays into Fe)
- Outer layers primarily form Si, Mg, S, and Ca



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Background

- Supernovae are classified spectroscopically
- Main indicator of type Ia supernovae is a prominent Si II absorption line

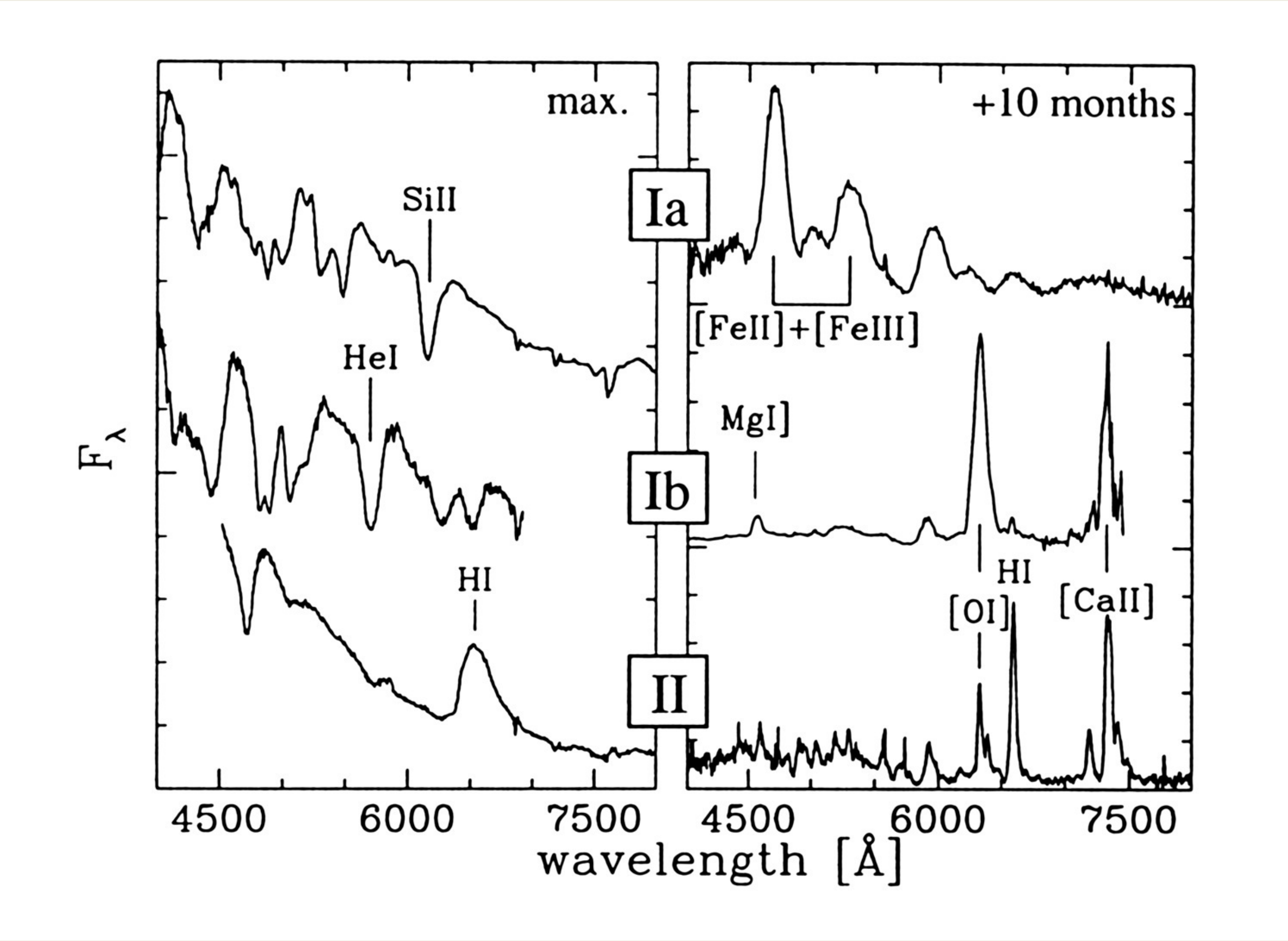


Image taken from Filippenko Annual Reviews of Astronomy & Astrophysics: "Optical Spectra of Supernovae"

Background

- Type Ia
- Located in NGC 5018, an elliptical galaxy in the Virgo constellation
- Discovered March 17th, 2021 by Koichi Itagaki
- Redshift = 0.0094

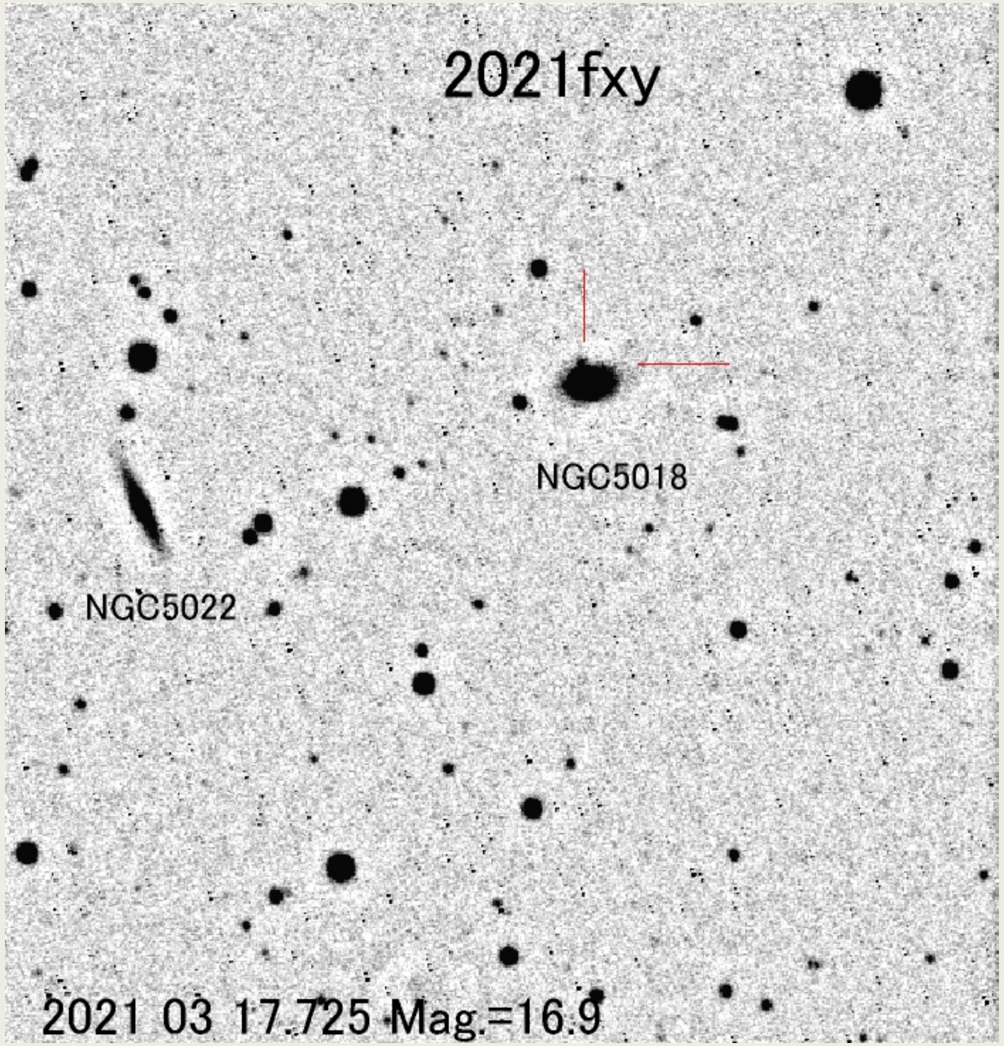


Image Credit: Koichi Itagaki

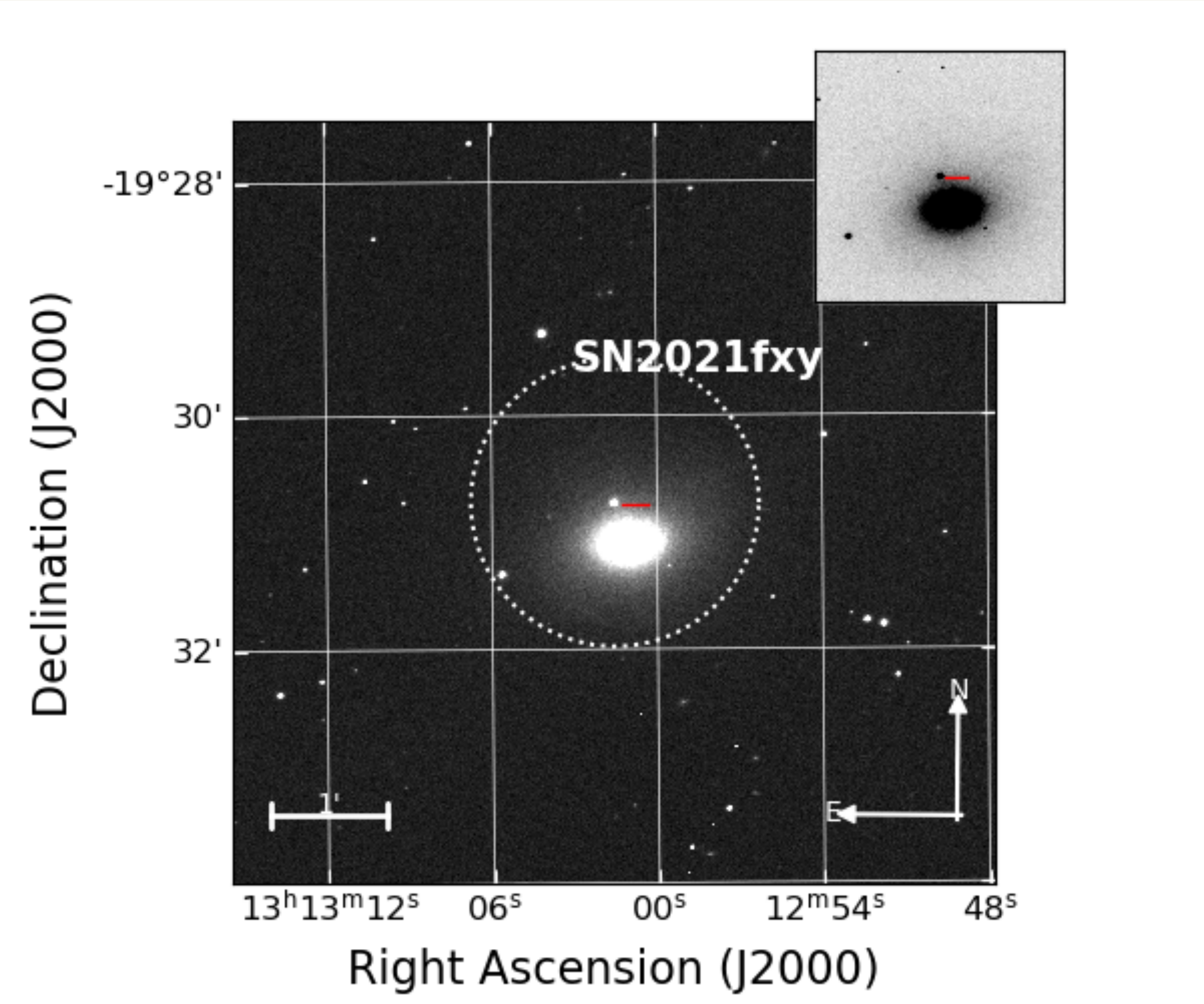


Image taken from Las Campanas using Swope 1-meter telescope

Why do we care?

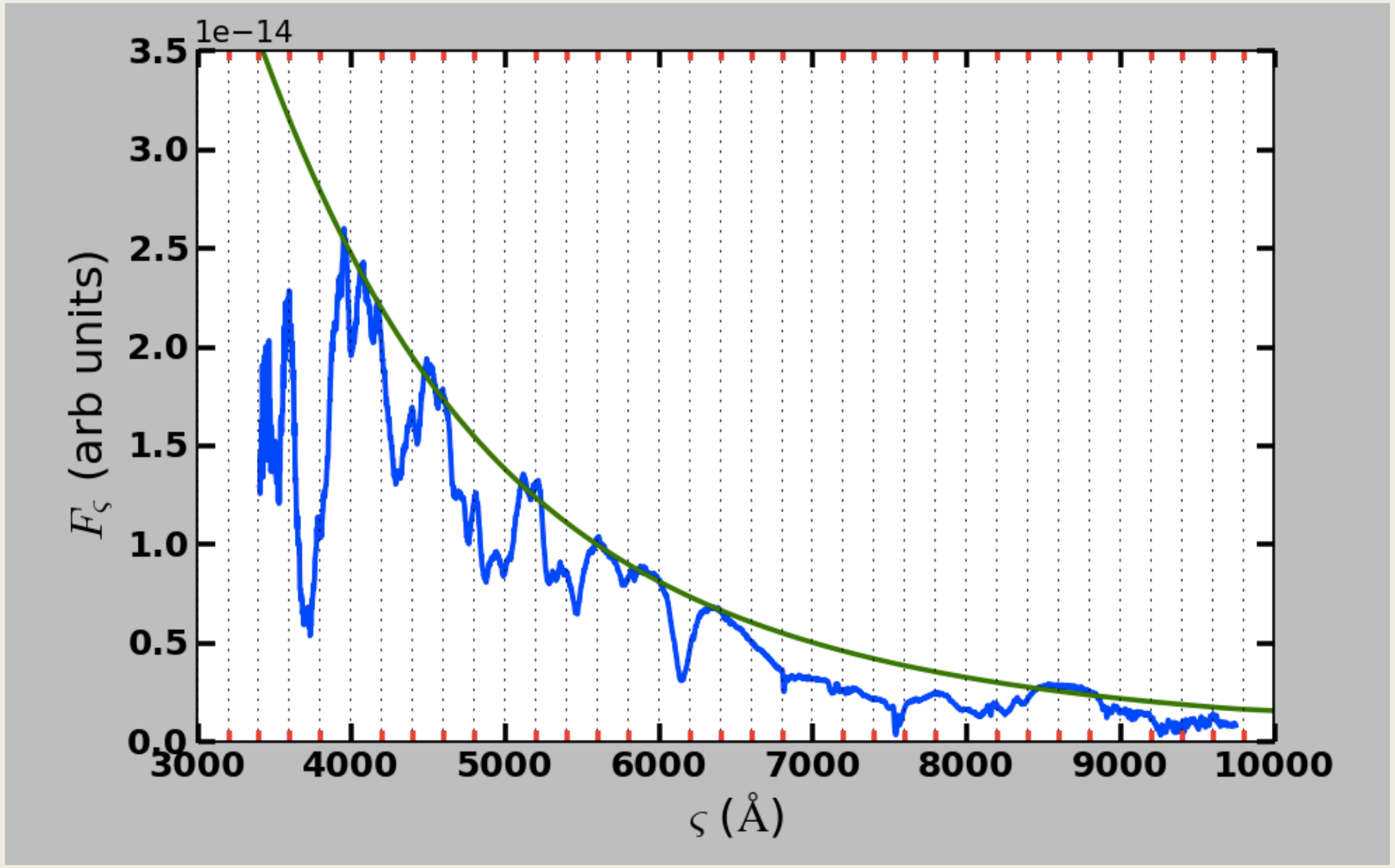
- Supernovae act as a standard candle
- Their brightness is used to measure far away distances
- Better understand type Ia supernovae themselves

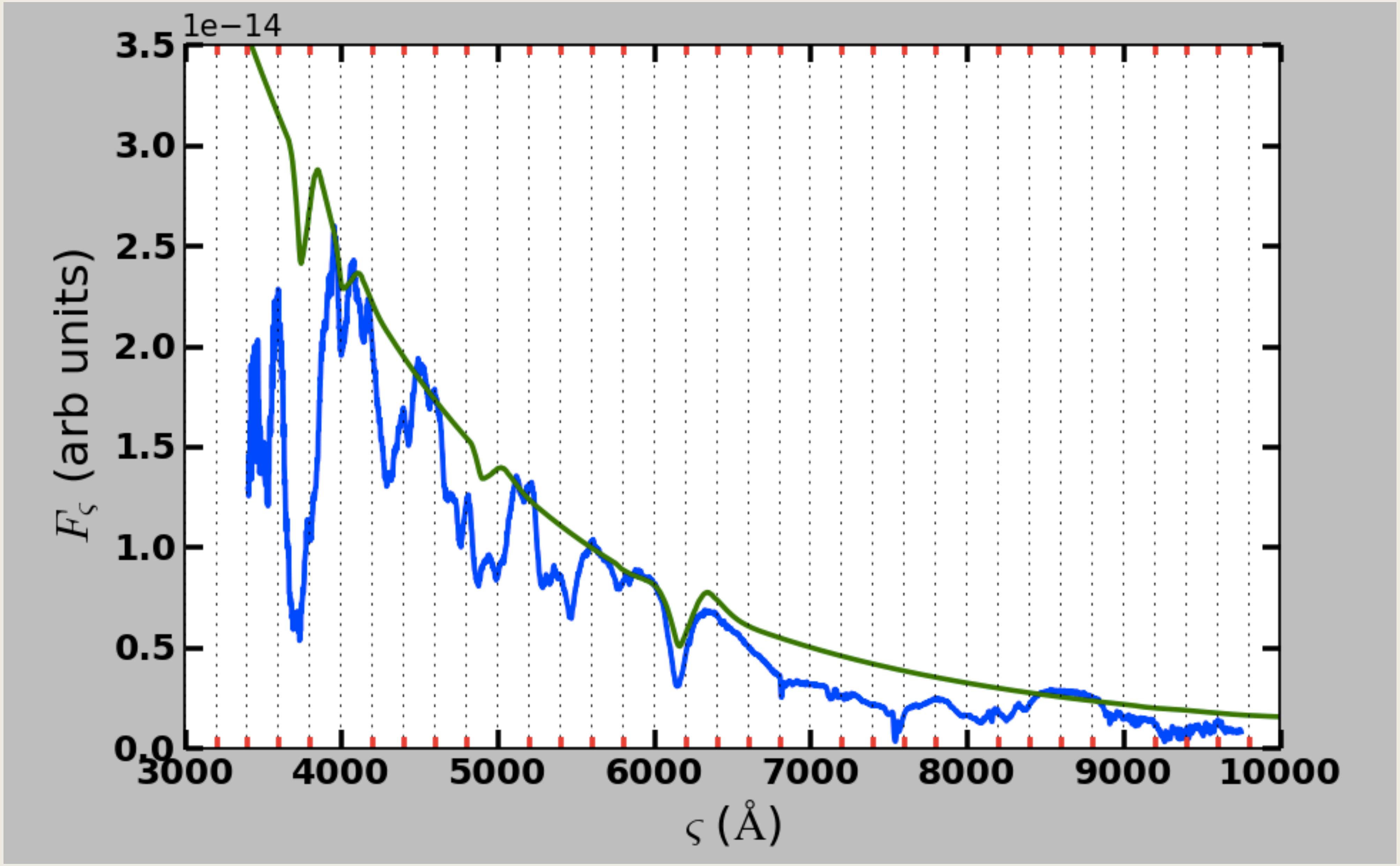
SYNOW

- Written by David Branch, updated by Adam Fisher
- Produce synthetic spectra to attempt to match the actual spectra
- Assumptions:
  - Spherical symmetry
  - Ejection velocity proportional to radius ($r = vt$)
  - Line formation by resonance scattering superimposed on a blackbody continuum

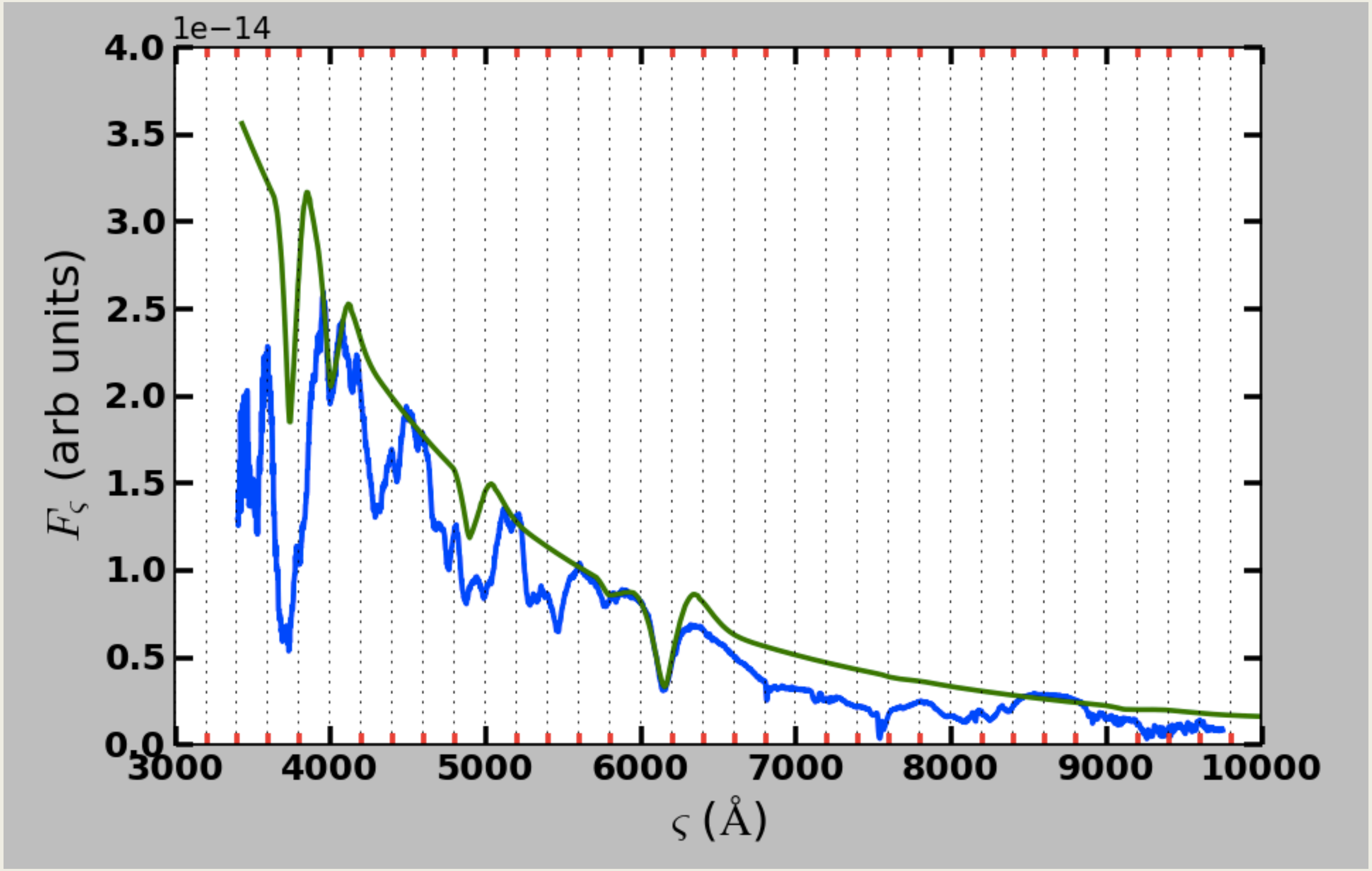
SYNOW

- Build spectra upon a blackbody
- Add on different ions one at a time
- Change optical depth, minimum velocity, maximum velocity, ionization temperature
- Get rough idea of ejecta's physical parameters





SN2021fxy April 1st spectra with only photospheric Si II; optical depth τ = 1.



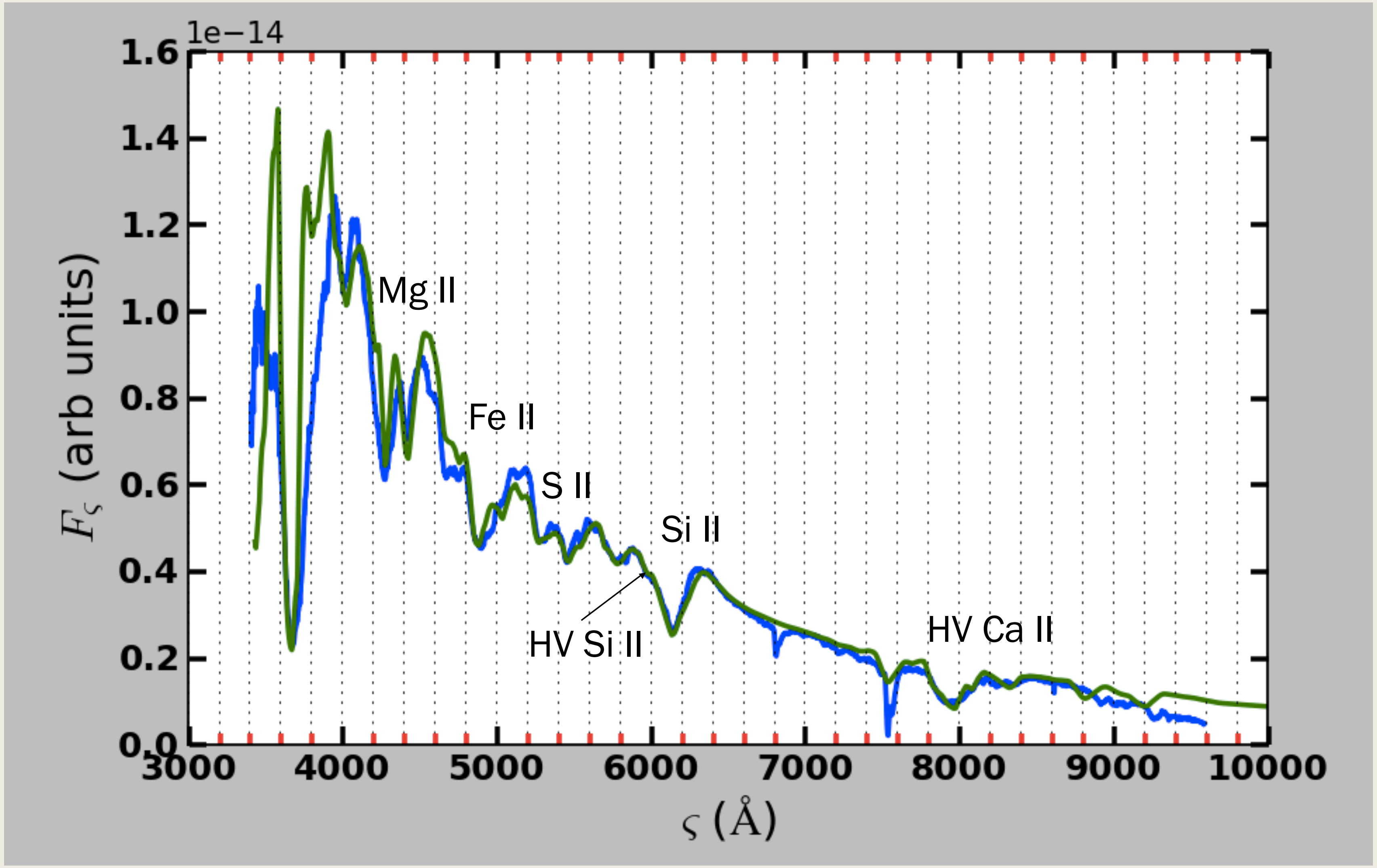
SN2021fxy April 1st spectra with only photospheric Si II turned on; τ = 3.

Summary of work

- Fit 4 spectra that range from 7 days before maximum light to 5 after
- Look for high-velocity features
- Figure which ions take different velocities from the photospheric velocity

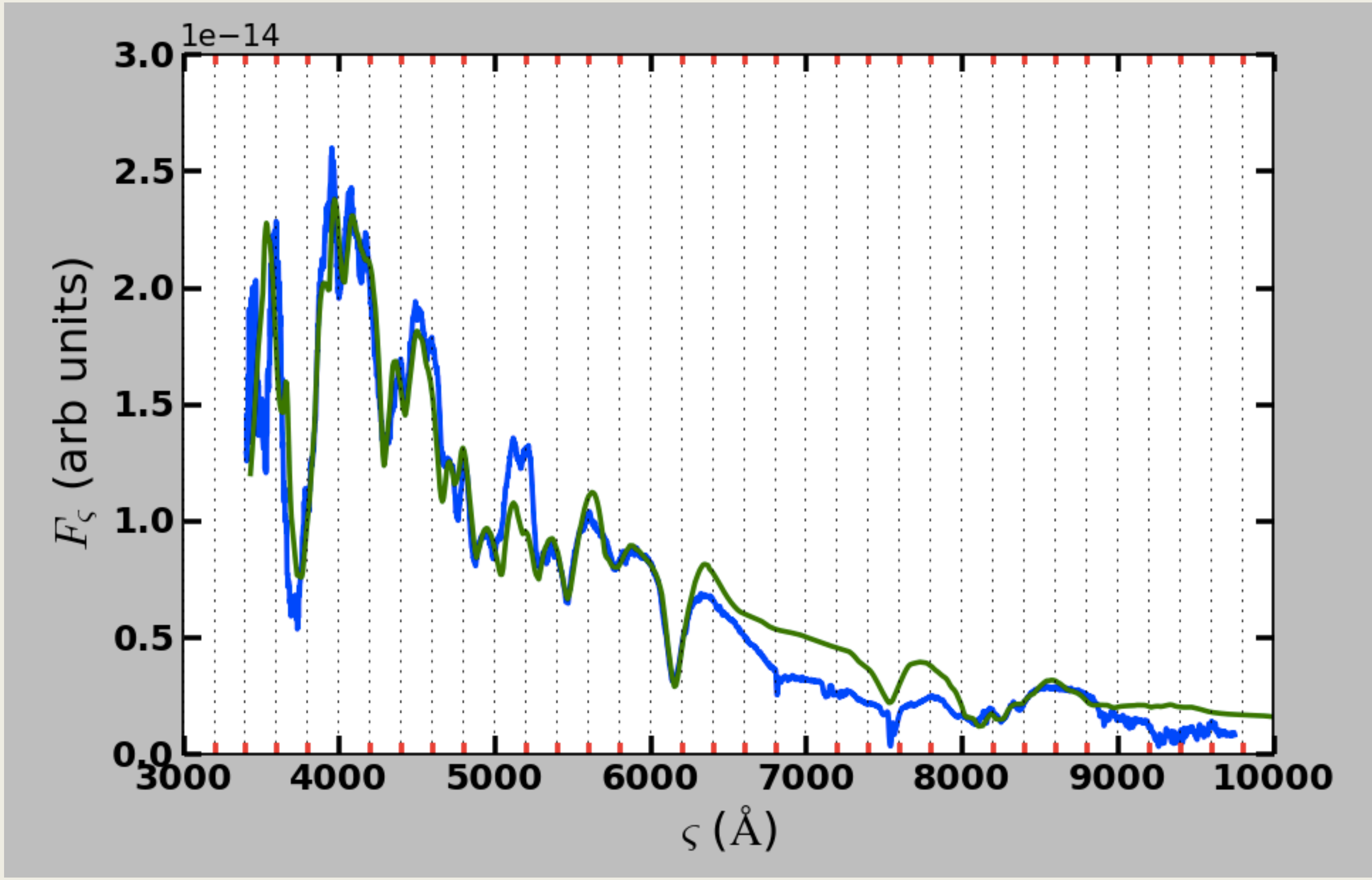
Fit spectra

- March 25th
- Pre-max light
- More doubly ionized features than future observations
- Presence of high-velocity Si II, Co III, and Ni III
- Photospheric velocity = 10800 km/s



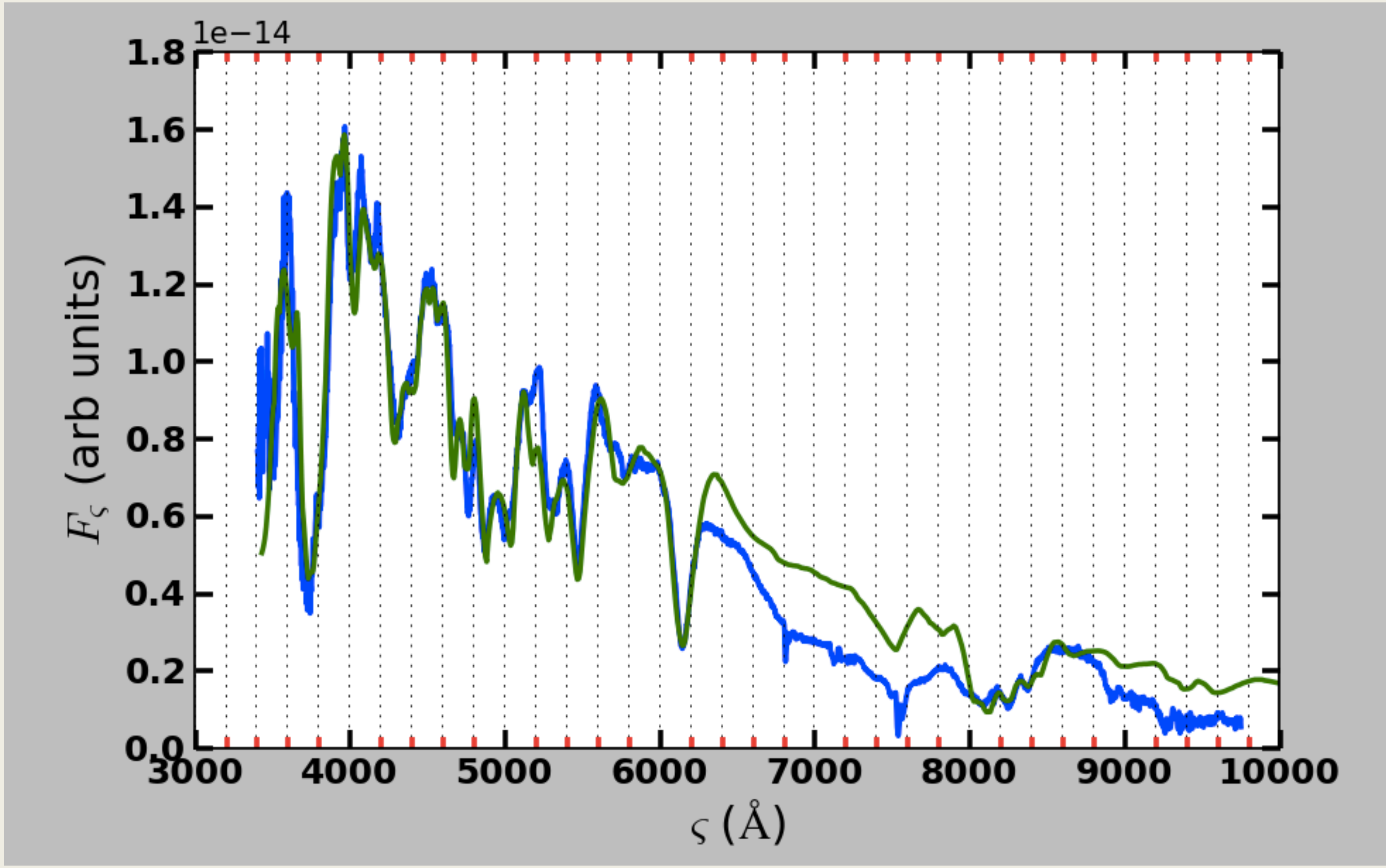
Fit spectra

- April 1st
- Max light
- No obvious high-velocity Si II, Co III, or Ni III
- Photospheric velocity of 10000 km/s



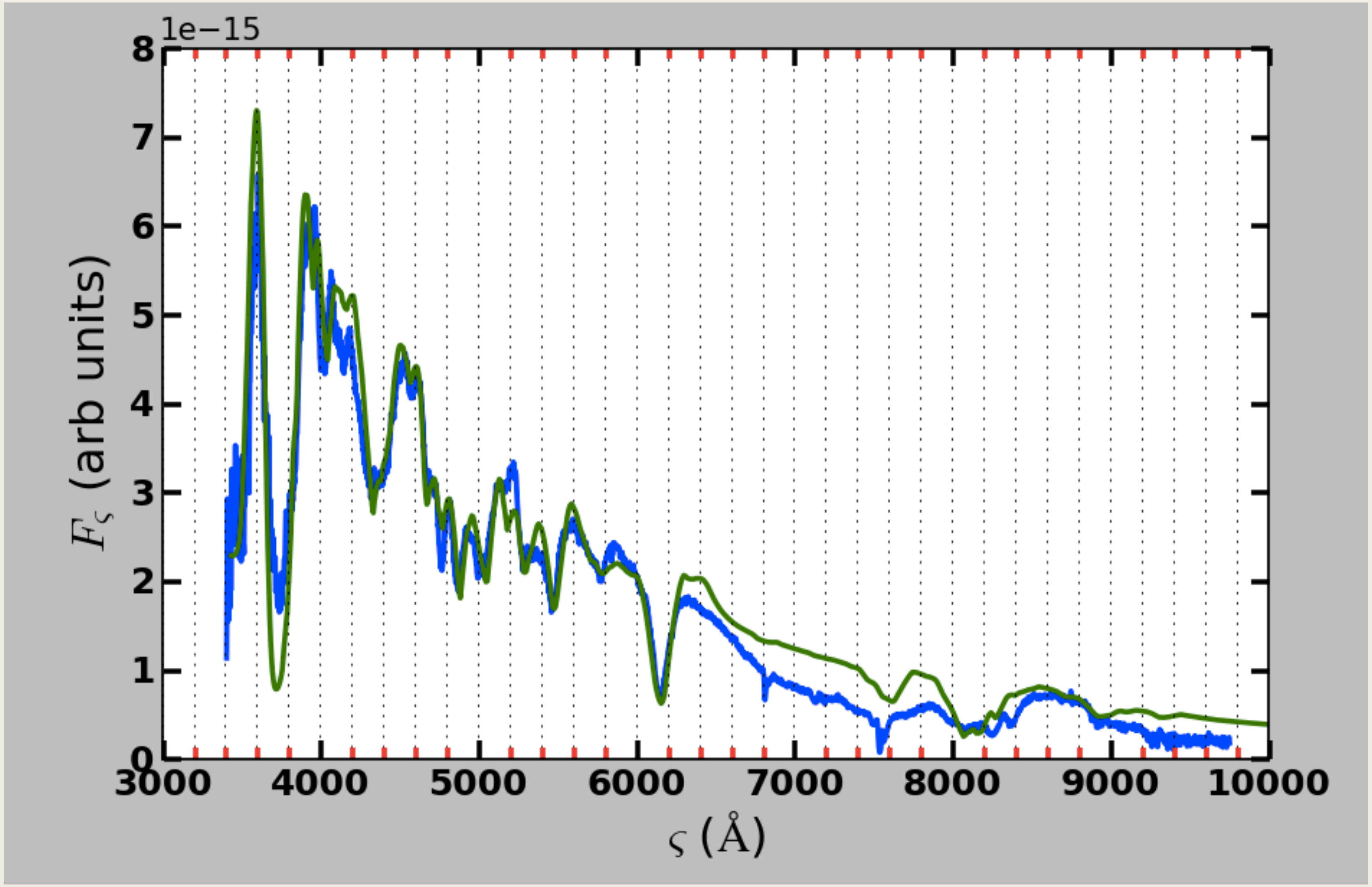
Fit spectra

- April 3rd
- Photospheric velocity = 10000 km/s
- Decrease in opacity of Silicon features



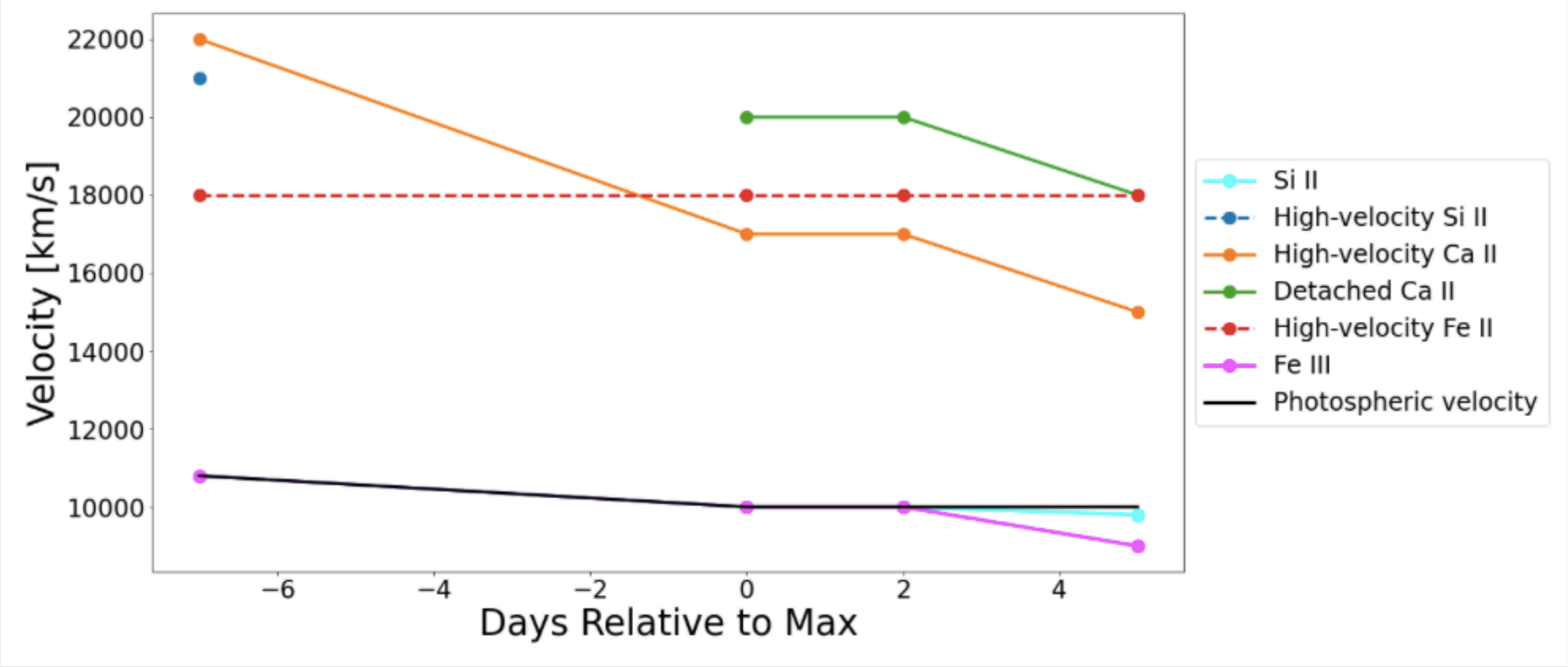
Fit Spectra

- April 6^{th}
- Photospheric velocity = 9000 km/s



Comparison of different ion velocities

- By tracing ion velocity evolution, we can see where the elements are located in the ejecta
- Compare to other models of supernovae explosions



Conclusions and future progress

- Fit 4 SYNOW spectra to 2021fxy’s observed spectra
- Understand how ion velocities evolve over time
- Continue refining fits
- Compare fits to other type Ia supernovae

Acknowledgements

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