

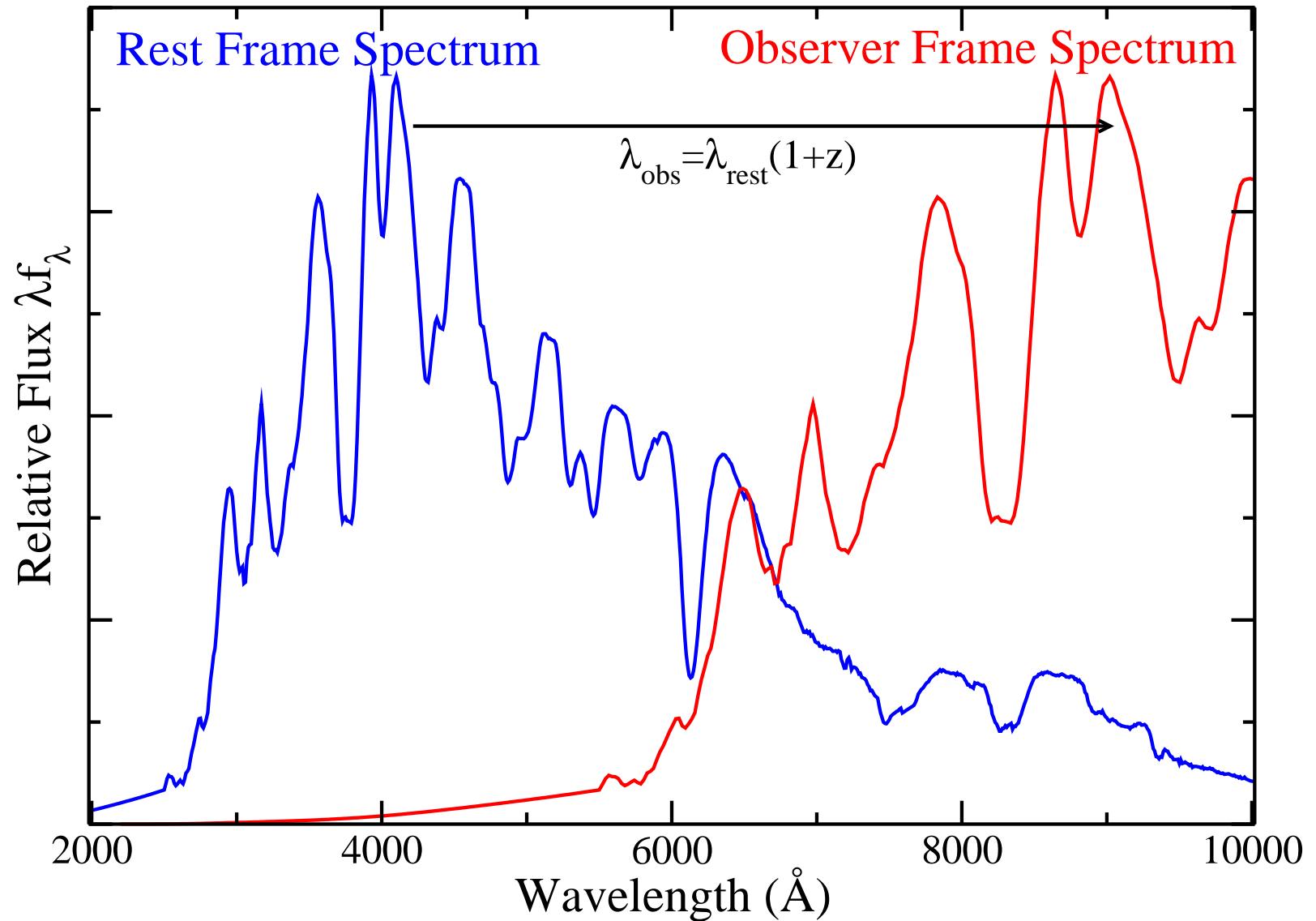
# Slouching Toward K-Corrections

Rollin Thomas – June 16, 2004

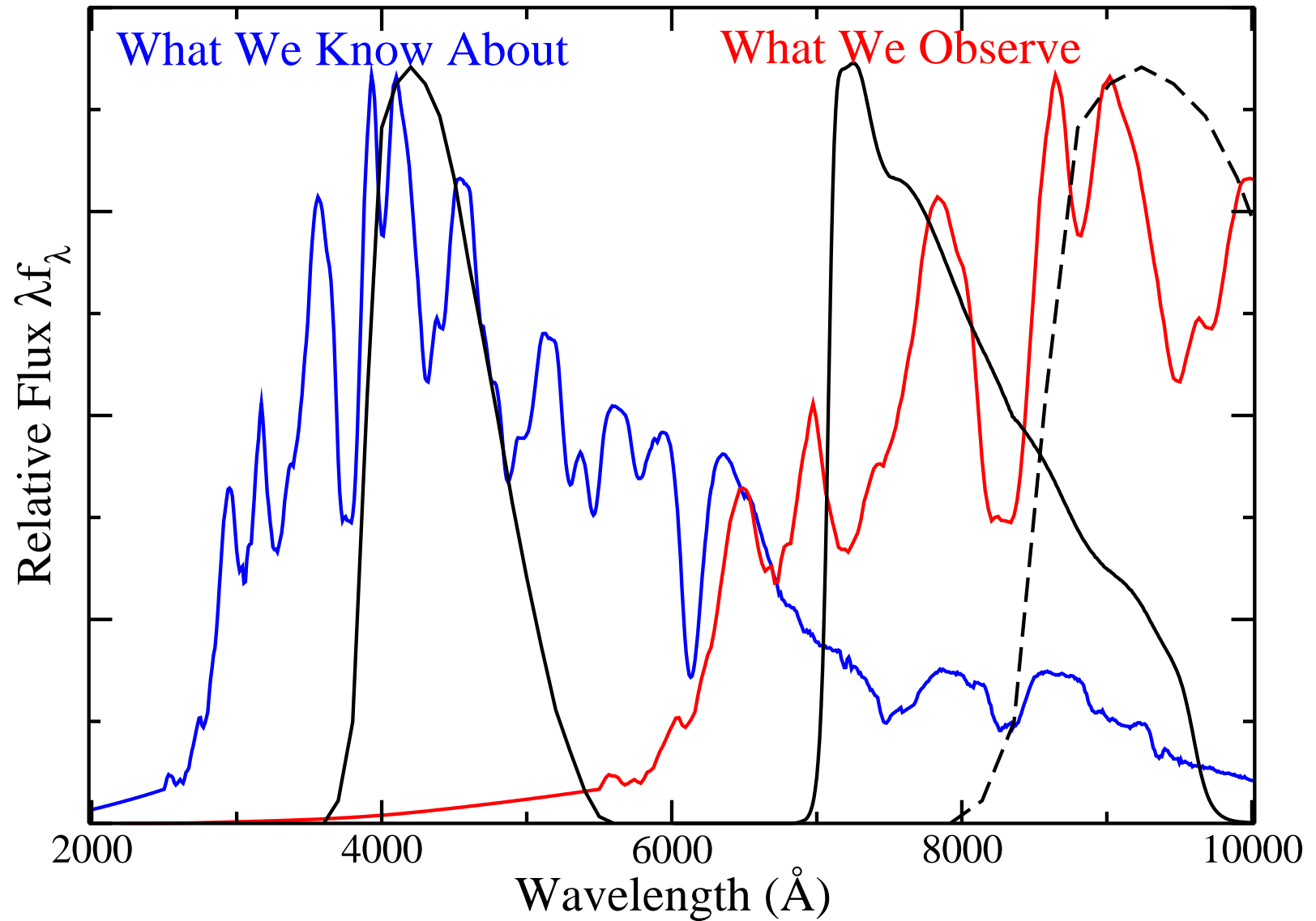
# What is a K-correction?

- Have to compare local objects to very distant objects.
- Radiation from vast distances suffers effects of cosmic expansion.
  - Photon arrival rates drop by  $(1 + z)$ .
  - Energies arriving drop by  $(1 + z)$ .
  - (One of those is canceled by number conservation).
  - The Doppler shift effect (redshift).

# Redshift's Effect on Spectra



# Redshift's Effect on Photometry



# Equations

$$m_y = M_x + \mu + A_x + A_y + K_{xy}$$

$$\begin{aligned} K_{xy} &= 2.5 \log(1 + z) \\ &+ 2.5 \log \left( \frac{\int \lambda d\lambda F(\lambda) S_x(\lambda)}{\int \lambda d\lambda F(\lambda/(1+z)) S_y(\lambda)} \right) \\ &- 2.5 \log \left( \frac{\int \lambda d\lambda Z(\lambda) S_x(\lambda)}{\int \lambda d\lambda Z(\lambda) S_y(\lambda)} \right) \end{aligned}$$

A K-correction looks like the difference of an observer frame magnitude and a rest frame magnitude computed at a standard distance.

# How Should One Do K-corrections?

- *Formally* there is no problem doing K-corrections like WFPC to B-band. It's just integration. Just watch your units.
- But if he hasn't said so already, Alex C. calls this a "wishful K-correction."
- Reason: It requires a spectrum fairy to give you the right spectrum. And you must have *faith*.
- How to contact spectrum fairy:
  - Supertelescope take the spectra (apostasy).
  - Find "similar  $l_0$ - $z$  object," integrate that (some faith).
  - Meld real spectra in  $(\lambda, t)$  (conversion).
- The first case is not an issue, we skip it.
- Issue for the other two is "color calibration."

# Debate

	Realspectrum	Überspectrum
Uncertainty	Use several	Wiggle $s, t, z...$ in MC
Ease-of-use	Harder	Very easy
Color adjustment	Weird inflections	Weird inflections
Needs high-priest	Probably	For production
Data pedigree	Usually gone	Known/confirmable
Extreme cases	If you've got one	Peter makes one

- NOTE: Überspectrum was always meant to be a stepping stone.
- When real spectra of the same quality as überspectrum are available, we migrate to those.
- To use existing literature data is a big headache.

# Uberspectrum Components

Supernova Name	Phases Relative to Maximum
1981B	0,17,20,26,35,49,58,64
1989B	-7,-5,-3,-2,-1,3,5,8,9,11,12,13,14,15,16,17,18,19
1990N	-14,-7,7,14,17,38
1992A	-5,-1,3,5,6,7,9,11,16,17,24,28,37,46,76
1994D	-10,-9,-8,-7,-4,-3,2,3,4,5,6,8,11,12,13,14,16,18,20,25
1992al	-5, 4
1990af	-2
1992ag	0
1992aq, bl, bo	2
1992bh, bs	3
1992bp, br	7
1992P	0
1992bc	-10
1993H	3, 5
1993O	-4, 2



# Uberspectrum Magnitudes

phase	U	B	V	R	I	J	H	K
-20.0	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$
-15.0	2.16	2.37	2.71	2.66	3.11	3.27	3.45	3.28
-10.0	0.43	0.83	1.13	0.84	1.11	1.69	1.87	1.70
-5.0	-0.25	0.13	0.26	0.21	0.48	0.82	1.00	0.83
0.0	-0.22	0.00	0.06	0.07	0.42	0.62	0.80	0.63
5.0	0.13	0.16	0.08	0.05	0.53	0.72	0.90	0.73
10.0	0.75	0.55	0.27	0.41	0.87	0.82	1.00	0.83
15.0	1.45	1.05	0.53	0.67	1.00	1.86	1.13	1.14
20.0	2.15	1.59	0.76	0.66	0.77	2.26	0.93	0.90
25.0	2.65	2.08	1.03	0.81	0.72	1.94	0.73	0.73
30.0	2.91	2.49	1.50	1.09	0.87	1.52	0.57	0.68
35.0	3.03	2.78	1.85	1.42	1.30	1.64	0.88	1.00
40.0	3.15	2.99	2.12	1.67	1.63	1.93	1.17	1.33
45.0	3.26	3.15	2.34	1.88	1.88	2.42	1.46	1.60
50.0	3.37	3.25	2.50	2.02	2.03	2.91	1.75	1.88
70.0	3.70	3.58	3.06	2.54	2.61	4.12	2.52	2.64

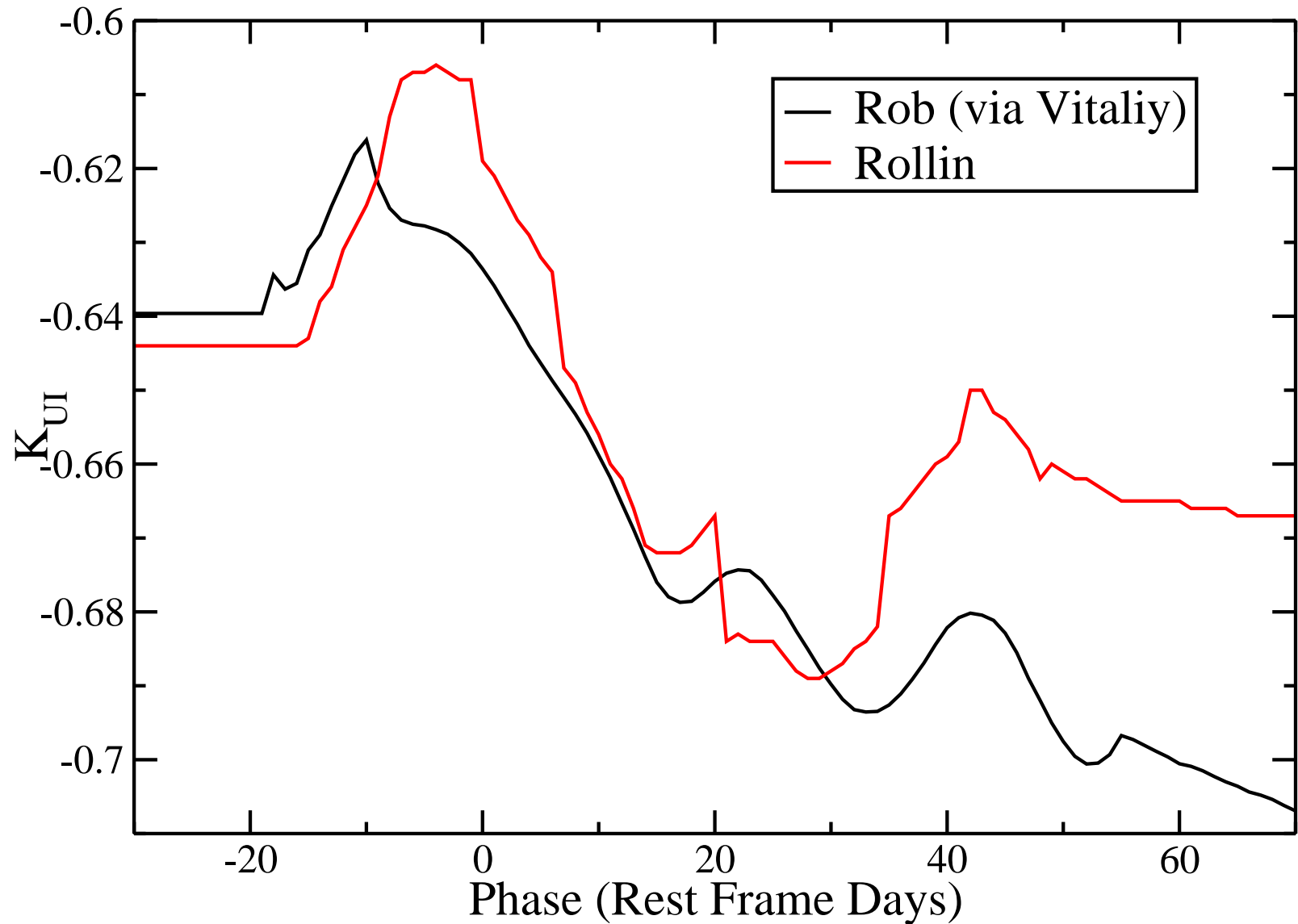
# Living in an Imperfect World

- Until SNFactory is done, we need options.
- For using real spectra,
  - Catalogue existing spectra by your likeness metric.
  - Make easy to select, look at, and use them.
- For using uberspectrum,
  - Catalogue this (these) too.
  - Make easy to compare visually to real spectra.
  - Make easy to compare color, magnitude, K-curves.
- In both cases,
  - Manipulation of filters should be easy.
  - Make easy to see effects of color calibration.

# Stuff Done So Far

- First draft,
  - Understand Peter's magnitude code.
  - Replicate it in modern Fortran.
  - Replicate Peter's colors and K-corrections.
- Database (dual purpose – also for SNFactory),
  - Ingested OU Spectrum Archive.
  - Added lightcurve parameterization (Lifan SS).
- Second draft,
  - Built around getting Albinoni's K-correction.
  - To satisfy software requirements, Perl/PDL.
  - Start with uberspectrum-based K-correction.

# Albinoni



# Stuff To Try Next

- Add color calibration stuff (copy Peter's new one).
- Take hard-coded Albinoni-specific stuff out.
- Generalize code so it doesn't just use Uberspectrum (database).
- Add fancy stuff and teach people to use it.
- Subaru and HST stuff.