# Investigating the Reliability of Photometric Redshifts

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## Abstract

Redshifts (z) are key in determining the distances of far-off galaxies. Spectroscopic redshifts provide the most accurate distance calculations with the smallest uncertainties, but spectroscopic data is significantly more expensive than photometric data (spatial/regular imagery data). We will compare the photometric redshift to the spectroscopic redshift of 4 galaxies within a range of 0.0029 < z < 0.400 to determine the viability of using photometric redshift values in further research. We will compare the uncertainties from both the spectroscopic and photometric redshifts and use both to calculate the Hubble constant, $H_0$, to give a real world example of the effect that the increased photometric redshift uncertainty has on research.

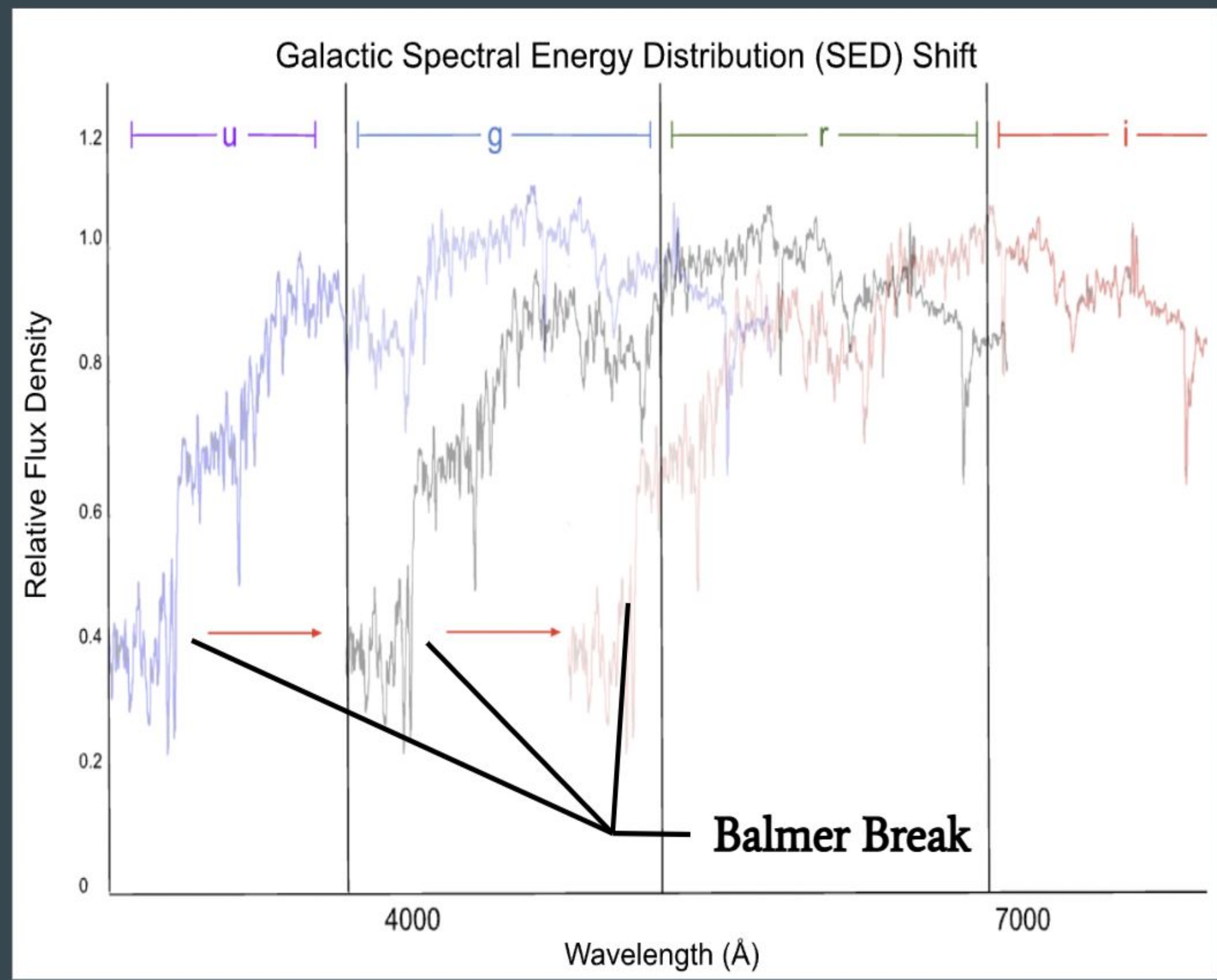



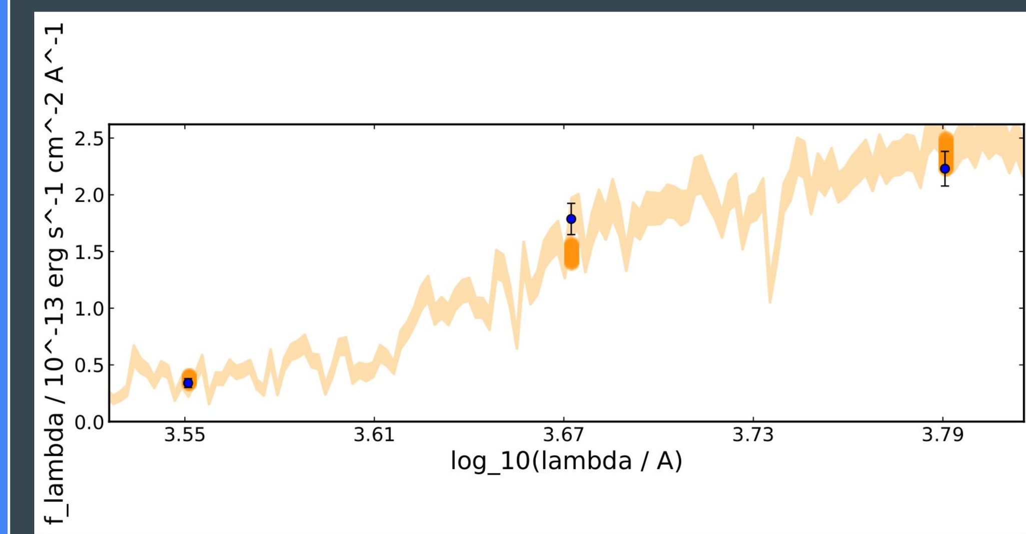

Figure 2: SED shift of Sa type galaxy across the SDSS filter ranges to illustrate the photometric redshift method.

## Background

The redshift of a galaxy describes the shift in wavelength of the spectral features of a galaxy due to its moving away from us. Spectroscopy itself is the study of the electromagnetic radiation emitted by matter and we can use features in the spectra to investigate how much they are shifted from a rest position which gives us the redshift. Photometric data itself is just an image which we can use to get the brightnesses of our objects. Using brightness data across many filters, we can put together a distribution of energy for the galaxy which can be fit to get a redshift using a coding algorithm. Using the redshifts we obtain from both spectroscopy and photometry, we are able to measure the Hubble's constant which is the key cosmological quantity that describes the rate of the expansion of the universe.

## Methods

While spectroscopic redshifts can be calculated by just looking at the shift in observed emission/absorption lines in our spectral data, photometric redshifts are a bit more complicated. This involves observing the ***shift in location of*** the Balmer or Lyman break in the Spectral Energy Distribution (SED) of the galaxy by noting the changes in flux across different photometric bands. This process is further illustrated in Figure 2. Using computer fitting routines, we are able to pinpoint a more exact shift of the flux of our galaxies based on their flux data across multiple photometric bands which can give us the redshifts of these galaxies!



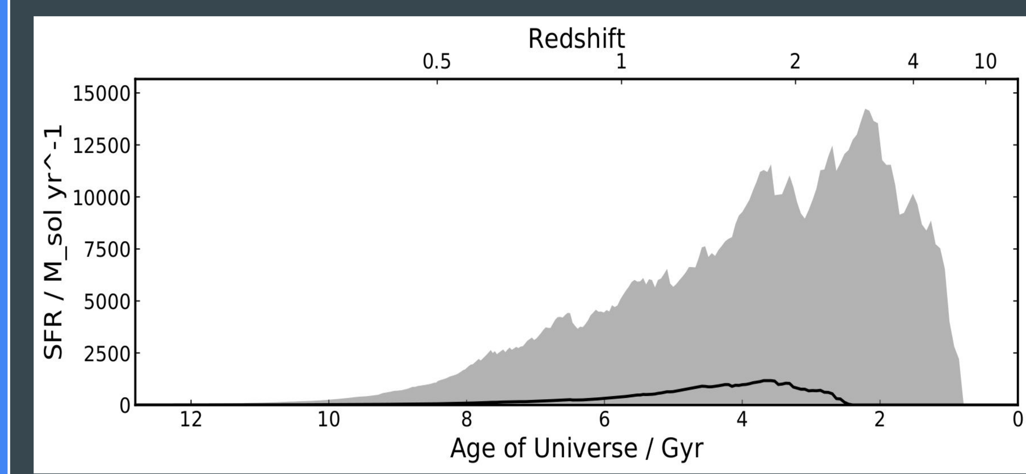




Figure 3 4: SED fit and SFH plot for NGC 5033.

## Results

From our investigation, we were able to confirm the consensus that spectroscopic redshifts do provide a more accurate and closely-bounded estimation of the redshifts to these galaxies as seen in both of the redshift columns in Table 1. As we can also see from the subsequent Hubble's constant estimations, the precision of these measurements does play out in their real world applications.

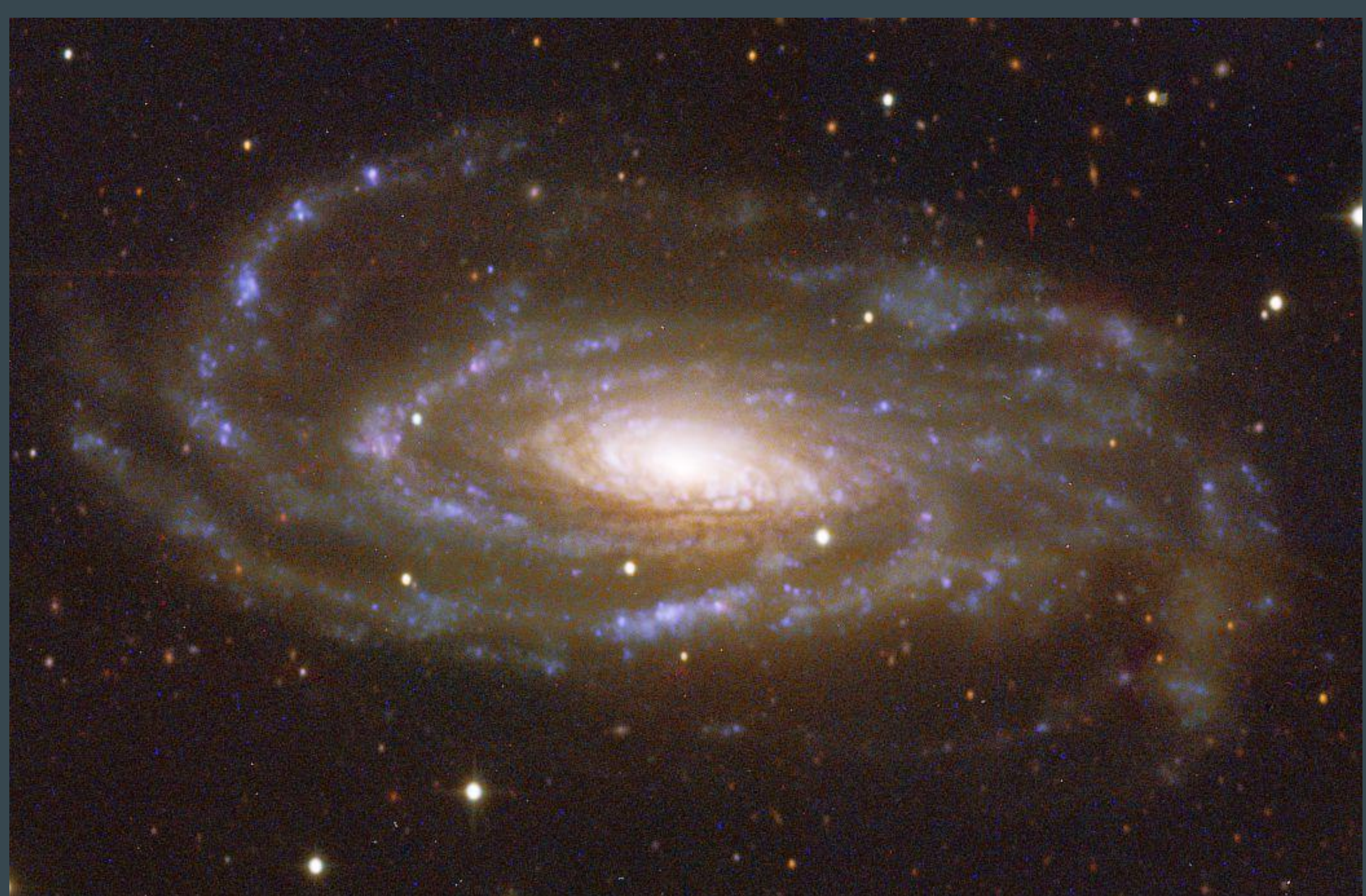


Figure 1: Three color image of galaxy NGC 5033 using our u, g, and r band observational data.

| Galaxy Name | Spectroscopic Redshifts | Photometric Redshifts | $H_0$ from Spectroscopy (km/s/Mpc) | $H_0$ from Photometry (km/s/Mpc) |
|---|---|---|---|---|
| NGC 5033 | 0.0029 +/- 0.0003 | 0.048 +/- 0.033 | 57.33 +/- 16.77 | 938.9 +/- 695.90 |
| IC 3606 | 0.1158 +/- 0.0019 | 0.080 +/- 0.052 | 102.14 +/- 4.07 | 70.54 +/- 46.23 |
| WISEA | 0.3989 +/- 0.0006 | 0.139 +/- 0.084 | 67.43 +/- 0.12 | 23.50 +/- 14.20 |
| IC 0801 | 0.0225 +/- 0.0004 | 0.386 +/- 0.229 | 66.7 +/- 1.76 | 1145.5 +/- 679.41 |

Table 1: All of our redshift and $H_0$ values from our observational data with their associated errors.