SUPERNOVAE & COSMOLOGY

Exercise sheet

1 SUPERNOVAE AS STANDARD CANDLES

From the measures of m and d reported in the table below, it is possible to find the *absolute magnitude* of each type Ia supernovae, because these quantities are related by the following equation:

$$d = 10^{(m-M_B-A+5)/5} \tag{1}$$

assuming that there is no extinction, so that $A = 0$. Compare the values of M_B that you obtained, what do you notice?

Table 1: PEAK MANGNITUDE AND DISTANCES OF SUPERNOVAE

m(mag)	d(Mpc)	M_B (mag)
8.25	3.19	
9.03	4.71	
10.54	9.18	
10.36	8.41	
9.95	7.09	
-0.82	0.05	

2 SUPERNOVAE LIGHTCURVESS

Since the value of M_B is equal for all type Ia supernovae (why?), it can be used to determine the distance, once the apparent magnitude of the peak is measured. Assuming $M_B = -19.3\pm0.03$ and $A = 0$, compute the distance of the Type Ia Supernovae INSERT SN NAME HERE from the light curve below
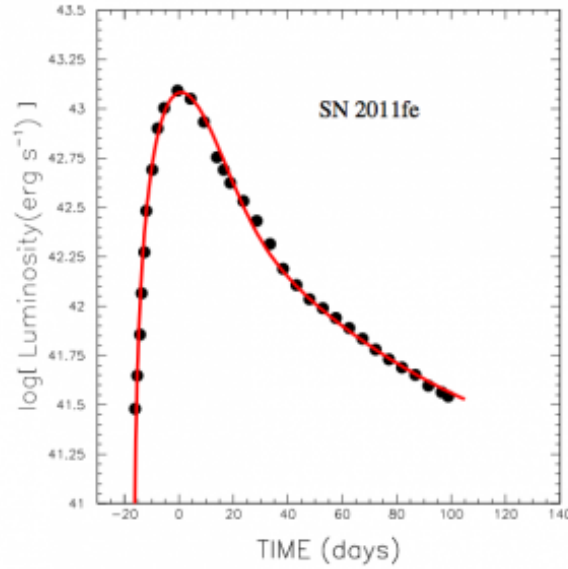

Figure 1: Lightcurve of a Type Ia Supernovae

knowing that the distance (in Mpc) is given by the following formula:

$$d = 10^{(m-M_B-A+5)/5} \tag{2}$$

assuming that there is no extinction, so that $A = 0$.

3   The Hubble diagram

Let's think about the expansion of the universe. Type Ia supernovae are very bright, thus they allow us to probe the universe up to very high distances. Since we learned how to compute their distances, with their recession velocity or their redshift is possible to trace a *Hubble diagram*. Its slope is the value of the *Hubble constant* H_0, that can be found from the *Hubble law* $v = H_0 d$, where v may be found from the redshift with $v = cz$. The dataset is the following:

Table 2: DISTANCE AND REDSHIFT OF SUPERNOVAE

Name	$m - M_B(\mathrm{mag})$	d	z	v (km/s)
SN2002fa	37.18		0.0584	
OGLE-2014-SN-036	36.16		0.034	
SN-2005-lm	37.91		0.08466	
PS15at	35.86		0.033	
CS5121211 : 040157 + 035721	37.6		0.07	
SN1999ee	33.1		0.011	

Compute the distance from formula (1), then from z compute $v = cz$, then plot the values of d and v. What kind of proportionality do you find? Please, compute it's value and discuss it.