Impact of SNIa on SED of high redshift galaxies

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Abstract. We present preliminary results on the effects of SNIa explosions on the Spectral Energy Distribution (SED) of distant galaxies and the possible modifications which may occur in integrated spectra, magnitudes and colours of simple galaxy models of different ages and metallicities few days after a SNIa event.

1 Introduction

Recent observations allowed to derive spectra of very high redshift galaxies ($z \gtrsim 3$) providing information on their earlier stage of evolution. Several authors infer galaxy ages by using the population synthesis technique and ages of the order of 1 Gyr or less have been suggested. We are interested in investigating the impact of SNe on the total emitted light of a galaxy in the range of ages running from 0.1 Gyr to few Gyr. The SNIa events should appear for ages comparable to the time scale of the first generation of white dwarf (WD) stars ($\approx 0.05 - 0.1$ Gyr). We suggest that SNIa may have a non-negligible impact on the SED of a galaxy. We assume few models for the stellar population synthesis which might be representative of the observed SED of high redshift galaxies and do not consider obscuration by dust. We stress that reproducing all the possible models which explain observed SEDs is not the goal of this work, while we focus our attention on the variations of the observable parameters when SNIa events are taken into account.

2 Photometric impact

The present knowledge of SN rates is still far from being firm. At high redshift, the effect of the expanding Universe will decrease the SN rate of a factor $(1 + z)$ due to time dilution, but the same effect will stretch the light curve of a SN by the same factor. Finally, one expects to observe a larger number of SNe Ia in the young Universe where we should observe the primeval galaxy population.

To evaluate the variation in the SED of the parent galaxy in case of a SNIa explosion, we assume a Simple Stellar Population (SSP) originated by a unique burst of star formation (Brocato & Romaniello 1997, in preparation) and the stellar atmosphere models by Kurucz 1995 are adopted.

The SNIa spectrum refers to SN 1992A (the optical part is kindly provided by B. Leibundgut whereas the UV part has been retrieved from the HST archive)
and it was obtained 5 days after the explosion. We simulated a SNIa event in 4 different galaxy models, namely, (i) $t = 0.1$ Gyr, $Z = Z_\odot$; (ii) $t = 1.0$ Gyr, $Z = Z_\odot$; (iii) $t = 0.1$ Gyr, $Z = Z_\odot/200$; (iv) $t = 1.0$ Gyr, $Z = Z_\odot/200$. We assume the V magnitude of the parent galaxy to be equal to that of the SN at the maximum ($V_{SN}^{max} = -19$ for $H_o = 75$ km s$^{-1}$ Mpc$^{-1}$, Wheeler & Benetti, 1996). The results are shown in Fig. 1 where we plot the SNia spectrum, the SED of the parent galaxy and the composite spectrum (galaxy + SNia). The some strong spectral features of the SNia can be clearly seen in large details making the SNia detection in distant galaxies a possible task. A rather interesting absorption is the SiII $\lambda\lambda 5972, 6355$ doublet.

3 Moving toward high redshift galaxies

We computed some significant colours for 4 galaxy models and plot the differences in these colours when the SNia is included (Fig. 2). With the exception of the galaxy with $t = 1$ Gyr and solar metallicity, the remaining 3 models have the
same behaviour. The J–K colour shows significant differences at high redshift, being around 0.5 at $z > 3$. The difference is even higher in the I–K colour. In the optical, the colour differences are significant only at low redshift ($z < 1$).

Fig. 2. Colour variations for 4 galaxy models due to the SNIa contribution.

One single SNIa event can dramatically change the SED of young galaxies. In general, for each given redshift there is a preferred colour in which the magnitude variation due to the SNIa event is larger. On the other hand, the SN rates at high redshift have never been tested. Simple considerations on the theoretical expectations and on the galaxy density at high redshift may allow the probability of finding SN events to be determined and to be compared with observations. This will also depend on the morphological galaxy type while the absorption features will be function of the galaxy metallicity.

References

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