Abstract. A type I supernovae (SN Ia) is an exploding white dwarf, whose mass exceeds Chandrasekar limit (1.44 solar mass). If a white dwarf is in a binary system, it may accrete matter from the companion, resulting in an excess mass that cannot be balanced by the pressure of degenerated electrons in the core. SNe Ia are highly luminous objects, that they are visible from very high distances. After some corrections (stretch (s), colour (c), K-corrections, etc.), the variations in the light curves of SNe Ia can be suppressed to be no more than 10%. Their high luminosity and almost uniform intrinsic brightness at the peak light, i.e. $M_B \approx -19$, make SNe Ia ideal standard candle. Because of their visibility from large distances, SNe Ia can be employed as a cosmological measuring tool. It was analysis of SNe Ia data that indicated for the first time, that the universe is not only expanding, but also accelerating. This work analyzed a compilation of SNe Ia data to determine several cosmological parameters ($H_0$, $\Omega_m$, $\Omega_\Lambda$, and $w$). It can be concluded from the analysis, that our universe is a flat, dark energy dominated universe, and that the cosmological constant $\Lambda$ is a suitable candidate for dark energy.

1. Introduction
The universe form from an event called Big Bang almost 14 billion years ago. In its early, universe is very hot and dense. When the universe expands, temperatures decrease enough to atom and then galaxies, stars, and planet because gravitation from giant cloud. Stars end their life in many ways. One of them is supernovae. Supernovae are stars that have reached the end of their life in very dramatic fashion with high explosion. Supernova Ia discovered in binary system consist of massive star and white dwarf. Massive star will transfer its energy to white dwarf until limit Chandrasekar ($\sim 1.44 M_\odot$) and exploded as Supernovae Ia (SN Ia).

Observations of SN Ia at low redshift ($z < 1$) provide indication that the expansion of the universe at the present time is accelerating [4,5,6]. This expansion has been attributed to a dark energy component with negative pressure and thus cause accelerated expansion. The results from SN Ia observation can constraint cosmological parameters like Hubble constant ($H_0$), matter density ($\Omega_m$), cosmological constant ($\Omega_\Lambda$), and equation of state ($w$). These results indicate that dark energy is the dominant component in the matter-energy budget of the universe [4,5,6].

Many surveys take observation for Supernova Ia to obtain more Supernova Ia data. Adding Supernova Ia data can constraint cosmological parameter with better precision. The goal of this work is to constraint cosmological parameters using SN Ia data, and combination of SN Ia + Cosmic Microwave Background (CMB) data from WMAP9 and Planck mission. The steps are fitting light curve, constructing Hubble diagram from SN Ia data, and constraining cosmological parameter with SN Ia, SN Ia + CMB from WMAP9, and Planck mission.
2. Dataset and fitter

2.1. Dataset
This work uses SN Ia sample data from [3] which refer to data from Supernova Legacy Survey (SNLS). The SNLS is a five year program to measure the expansion history of the universe using SN Ia. Since SN Ia is not perfect standard candle, selection and correction requirements applied in this sample. The selection requirements exclude known peculiar Supernovae, exclude SN Ia with peculiar spectroscopy, and require minimum redshift cut at $z = 0.010$, stretch ($s$), and color ($c$) factor. The final sample from [3] contain 123 low redshift data ($\leq 0.1$), 92 intermediate redshift data from SDSS II ($0.1 < z < 0.4$), 241 SNLS data ($0.3 < z < 1$), and 12 high redshift data from Hubble Space Telescope (HST) with $z > 1$.

2.2. Fitter
The importance of modelling Supernovae light curves is clear from the large number of methods that have been developed for this purpose. We fit all SN Ia light curve data with fitter SiFTO [2]. SiFTO is a new empirical method for modelling SN Ia light curves by manipulating a spectral template. This program will give three result parameters for each Supernova Ia. The results are peak magnitude at rest frame ($m_B$), shape that indicates stretch ($s$), color ($c$) that indicates maximum color at rest frame.

Confidence level for fitting cosmological parameter is illustrated with map contours. We use cosmoMC program to plot confidence level. CosmoMC decide confidence level contour by Monte Carlo method and measure likelihood for each cosmological parameters by SN Ia+CMB data.

3. Analysis

3.1. Light curve
Building SN Ia light curve is important step before constraining cosmological parameters. Shown below are examples of SiFTO fitting to SN Ia light curves (figure 1) for a low redshift (sn1997do) and a high redshift (Aphrodite). Table 1 shows the result of fitting parameter light curve with SiFTO. On the upper of x-axis there is effective day where 0.0 effective day corresponds to maximum flux, while negative and positive effective day correspond to interval time before and after maximum flux, respectively.

![SiFTO fitting to sn1997do (left) and Aphrodite (right) flux. The dashed line are the error snake for the template.](image.png)
Table 1. Light curve parameters for sn1997do and Aphrodite.

|                | Sn1997do          | Aphrodite         |
|----------------|-------------------|-------------------|
| Redshift (z)   | 0.01012 ± 0.00002 | 1.3000 ± 0.01000  |
| Stretch (s)    | 0.947 ± 0.027     | 1.050 ± 0.048     |
| Color (c)      | -0.006 ± 0.027    | -0.028 ± 0.056    |
| Peak magnitude | 14.274 ± 0.039    | 25.673 ± 0.035    |

3.2. Hubble diagram

Hubble diagram is built from relation between redshift and distance modulus. Corrected magnitude, stretch (s) and color (c), use formula [3]:

$$m_{corr} = m_B + \alpha(s - 1) - \beta c$$ (1)

$$\mu_{corr} = m_B + \alpha(s - 1) - \beta c + 19.3$$ (2)

where $m_{corr}$ is corrected magnitude, $m_B$ is peak magnitude at B band rest frame, $\alpha$ and $\beta$ are coefficients for s and c, and $\mu_{corr}$ is magnitude if we changed the equation to distance modulus ($M_B = -19.3 \pm 0.3$ [1]). We use value $\alpha = 1.43^{+0.12}_{-0.10}$ and $\beta = 3.26^{+0.12}_{-0.10}$, which is the best fitting results from [3]. Distance modulus can be transformed to luminosity distance:

$$\mu = 5 \log d_L + 25$$ (3)

$$d_L = cH_0^{-1}(1 + z) \times \int_0^z dz[(1 + z)^3(\Omega_m) + (1 - \Omega_m)(1 + z)^3(1+w)]^{-1/2}$$ (4)

where $\mu$ is distance modulus, $d_L$ is luminosity distance, and $w$ is equation of state. If $w > -1/3$, universe will experience accelerated expansion, but if $w < -1/3$ universe will experience decelerated expansion. Hubble diagram in luminosity distance is shown in figure 2 with flat model universe. Figure 2 shows SN Ia data fitted with flat model universe which is dominated by dark energy. Moreover, when SN Ia data is fitted with fixed $\Omega_m = 0.18$ and $\Omega_\Lambda = 0.82$, the result shows SN Ia data is fit well with $w = -1$, indicating accelerated expansion of the universe. The linear part of the Hubble diagram corresponding to low redshift SN Ia data ($z \leq 0.1$), is used for measuring Hubble constant ($H_0$). Luminosity distance at linear part can be approximated by $d_L \approx c(1+z)/H_0$, giving value of $H_0 = 69.78 \pm 2.10$.

![Figure 2](image-url) Hubble diagram in luminosity distance with three flat models (left) and with $\Omega_m = 0.18$ (right).

3.3. Confidence level

Contours of confidence level generated by using cosmoMC for SN Ia+CMB data from 9th year WMAP and Planck shown in figure 3. Best fitting of cosmological parameters from SN Ia+CMB data are shown

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[Image references and Table 1 are included in the text.]
in table 2. Dark energy density shows higher value than matter density, indicating accelerated expansion of the universe.

Figure 3. Contours of confidence level (68% and 95%) for SN Ia+CMB data from WMAP9 (left) and Planck (right).

Table 2. Best fits of cosmological parameters from Supernova Ia+CMB data.

|                | SN Ia + WMAP9 | SN Ia + Planck |
|----------------|---------------|----------------|
| Ωm            | 0.28          | 0.31           |
| ΩΛ            | 0.72          | 0.69           |
| w             | -1.00         |                |
| H₀             | 69.82         | 67.80          |
| Age (Gyr)     | 13.75         | 13.78          |

4. Conclusion
We have presented determination of the cosmological parameters from data of the first three years of the SNLS and combining them with external SN data sets at higher and lower redshift. From SN Ia data only, we find H₀ = 69.77, Ωm = 0.18, ΩΛ = 0.82, and w = -1. From SN Ia+CMB data, we find H₀ = 69.82, Ωm = 0.28, ΩΛ = 0.72, w = -1 for SN Ia+WMAP9 and H₀ = 67.80, Ωm = 0.31, ΩΛ = 0.69 for SN Ia+Planck. Both results agree with SN Ia data only as analyzed in this work. All these results suggest an accelerated expansion of the universe, due to the dominance dark energy component.

References
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