



Monitoring and modeling of type IIP supernovae.

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Introduction

Core collapse supernova 2012aw (type IIP) was discovered on 2012 March 16.86 UT in the spiral galaxy M95 (NGC 3351) at the coordinates $\alpha = 10^{\text{h}} 43^{\text{m}} 53^{\text{s}}.76$, $\delta = +11^{\circ}40'17''.9$. This is nearby supernova, a distance to M95 is estimated about 10 Mpc. SN 2012aw belongs to normal class of type IIP SNe similar to SN 1999em.

Monitoring

We present the results of our observations obtained with two telescopes (fig. 1). Data were processed using package PHOT developed by Larionov V.M. BVRI light curves of SN 2012aw were mainly presented by Dall'Ora et al. (2014) [1] and Bose et al. (2013) [2]. In figure 2 we compare our photometric data with ones published in these articles [1], [2].

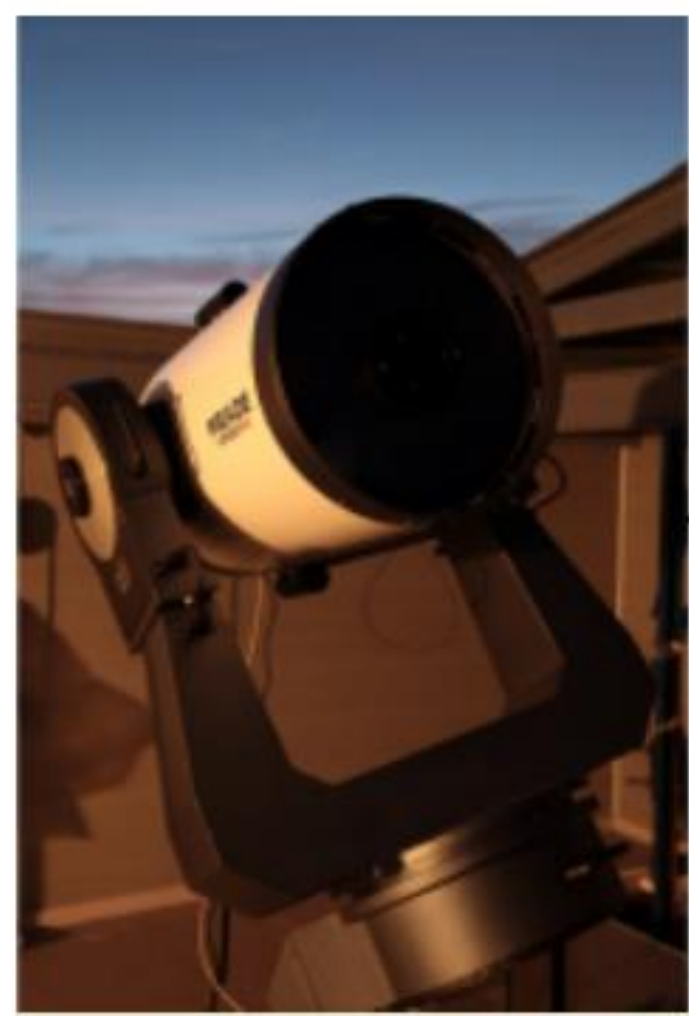


Fig. 1. a) LX200 (D = 40 cm), Saint Petersburg State University, Peterhof, b) AZT-8 (D = 70 cm), Crimean Astrophysical Observatory, Nauchny.

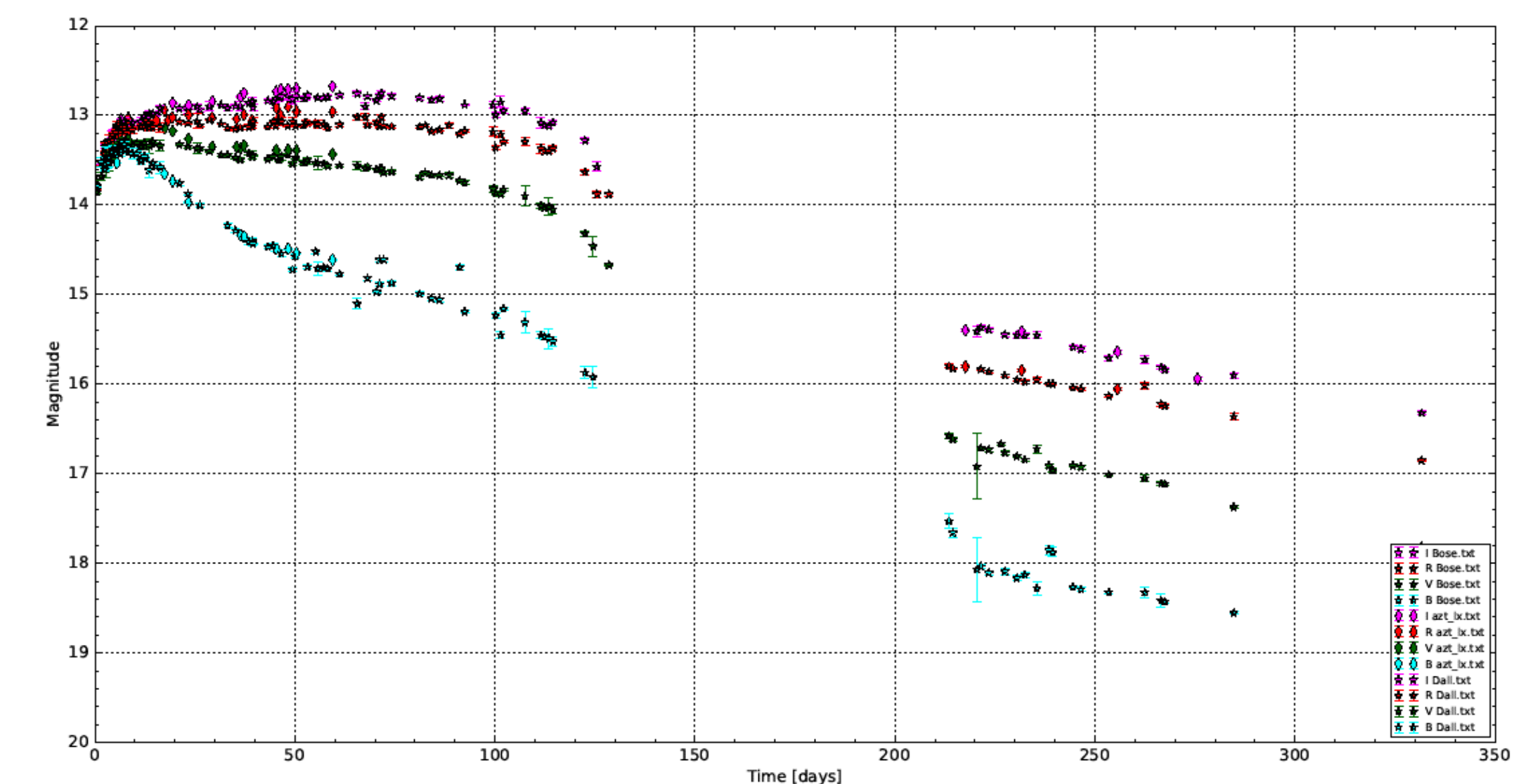


Fig.2. Results of our photometry compared with data from articles [1], [2].

Hydrodynamical model

Some parameters of SN 2012aw were calculated in a number of works. Dall'Ora et al. [1] estimated physical parameters with their radiation-hydrodynamics code: initial ^{56}Ni mass $\approx 0.06 M_{\odot}$, envelope mass $M \approx 20 M_{\odot}$, progenitor radius $R \approx 430 R_{\odot}$, explosion energy $E \approx 1.5 \text{ foe}$.

Bose et al. [2] presented: mass of progenitor star is about $M \approx 14\text{-}15 M_{\odot}$, explosion energy 1-2 foe, mass of nickel is ^{56}Ni mass $\approx 0.058 \pm 0.002 M_{\odot}$.

Van Dyk et al. [4] gives radius of progenitor $R \approx 1040 \pm 100 R_{\odot}$, initial mass of star $M \approx 17\text{-}18 M_{\odot}$.

We use package STELLA developed by Blinnikov S.I et al. [3] for constructing a hydrodynamical model of the SN 2012aw burst. We selected model with the best fit of the observations (fig. 3): the mass of envelope $M \approx 22 M_{\odot}$, progenitor radius $R \approx 500 R_{\odot}$, mass of nickel is ^{56}Ni mass $\approx 0.06 M_{\odot}$. explosion energy 1.2 foe. Figure 4 present photospheric velocity for this model compared with velocities estimated Bose et al. [2] from the SYNOW modeling.

We adopt a total extinction $A(B) = 0.36 \pm 0.07 \text{ mag}$ and the distance modulus $\mu = 29.96 \text{ mag}$ as the mean value between data from literature.

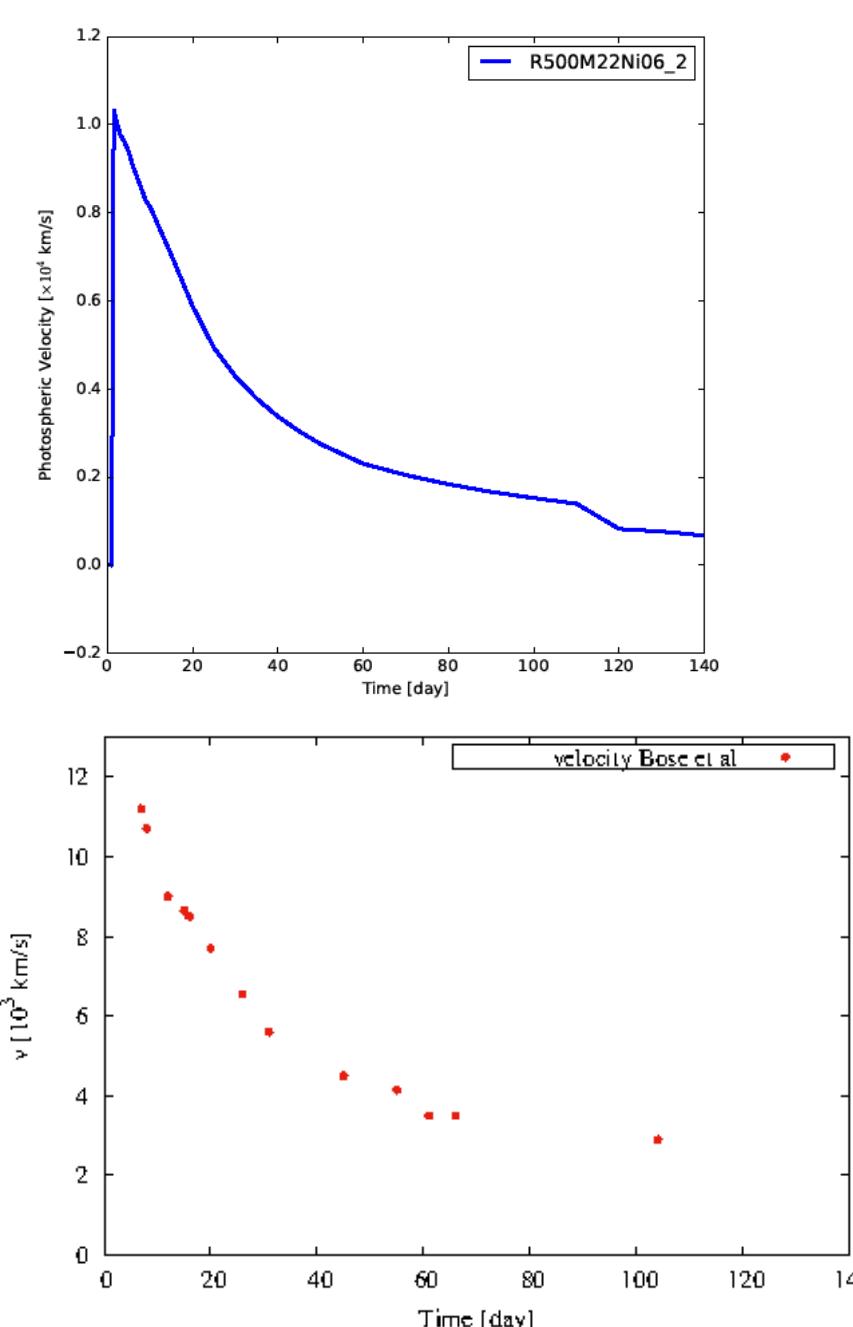


Fig.4. Photospheric velocity for 2012aw model (blue) and line velocities Fe II, He I 5876 A from [2] (red).

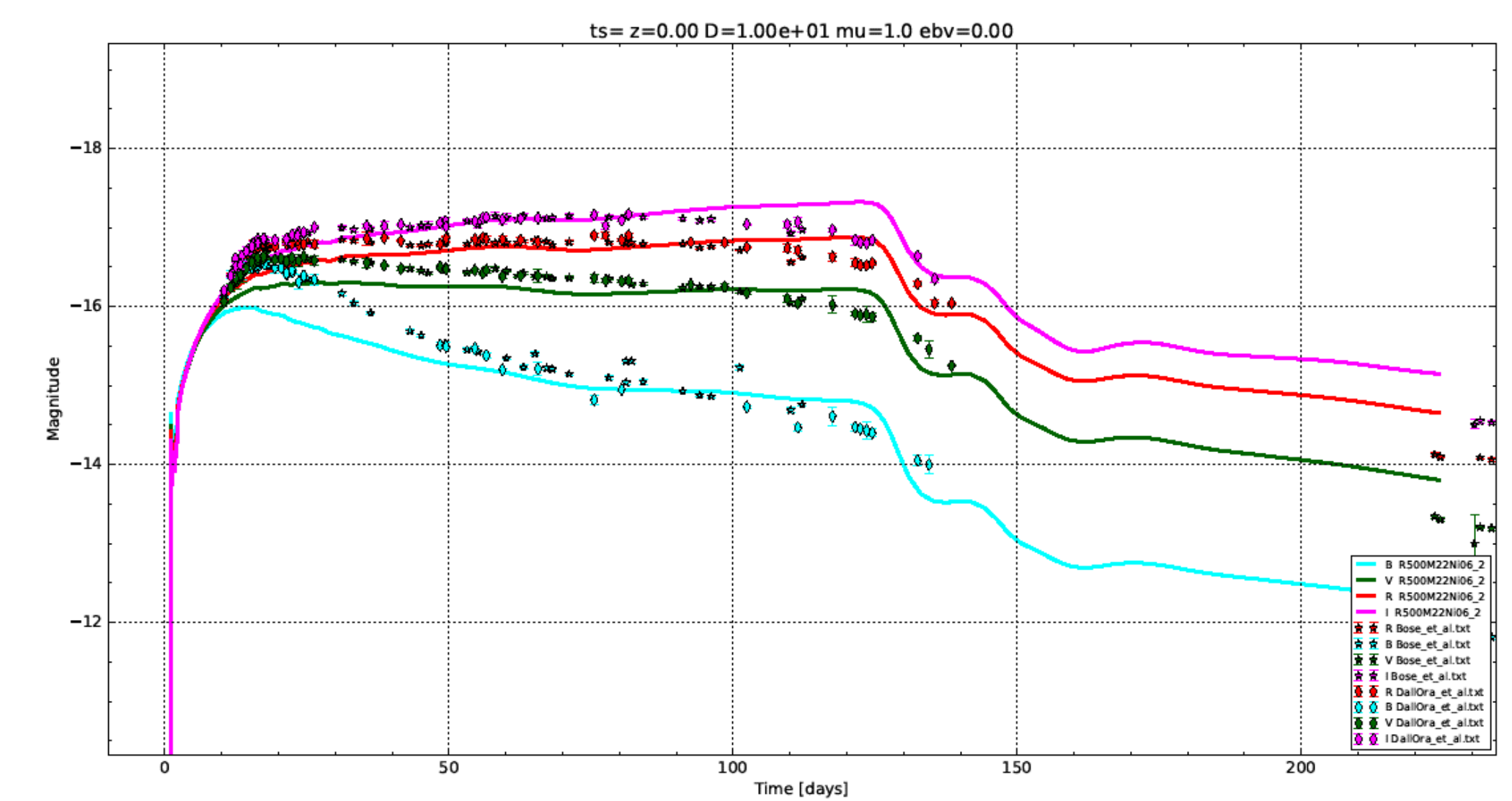


Fig.3. Results of modelling and observational data.

Conclusions

- BVRI photometry from AZT-8 and LX200 telescopes has good agree with published data.
- One can describe observational data of SN 2012aw using presented here model (fig. 3) with main parameters: $M \approx 22 M_{\odot}$, $R \approx 500 R_{\odot}$, ^{56}Ni mass $\approx 0.06 M_{\odot}$ and $E \approx 1.2 \text{ foe}$.

References

- [1] Dall'Ora, M., Botticella, M. T., Pumo, M. L., et al. *THE TYPE IIP SUPERNOVA 2012aw IN M95: Hydrodynamical modeling of the photospheric phase from accurate spectrophotometric monitoring*. The Astrophysical Journal, 787(2): 139, (2014).
- [2] Bose, S., Kumar, B., Sutaria, F., et al. *Supernova 2012aw - A high-energy clone of archetypal Type IIP SN 1999em*. Monthly Notices of the Royal Astronomical Society. 433(3): 1871-1891, (2013).
- [3] Blinnikov, S., Bartunov, O. *STELLA: Multi-group Radiation Hydrodynamics Code Astrophysics Source Code Library*, record ascl:1108.013 (2011).
- [4] Van Dyk, S.D., Cenko, S.B., Poznanski, D. *The red supergiant progenitor of supernova 2012aw (PTF12BVH) in Messier 95*. The Astrophysical Journal, Volume 756, Issue 2, article id. 131, 9 pp. (2012)