Team Members

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University of Texas

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UC Berkeley

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Lawrence Berkeley National Lab
Super Luminous SNe

Smith+ 2007

Talk : Smith  Posters : Quimby, Moriya

Thursday, October 11, 12
 ordinary core collapse supernovae

peak luminosity (ergs/sec)

light curve duration (days)

(From Kasen)
type Ia
(From Kasen)

ordinary core collapse supernovae
ordinary core collapse supernovae

(type Ia

(From Kasen)
ordinary core collapse supernovae

(type Ia) 2005ap 2008es

.more massive, opaque (longer diffusion time)

(From Kasen)
more massive, opaque (longer diffusion time)

more energetic, larger radius

From Kasen
More massive, opaque (longer diffusion time)

Type Ia:
- 2005ap
- 2008es
- ptf09cnd
- scp06f6
- 2006gy
- 2007bi

Ordinary core collapse supernovae

More energetic, larger radius

(From Kasen)
# The Death of Massive Stars

Woosley, Heger, & Weaver (2002)

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<th>MS Mass</th>
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(CCSNe Talks: Janka, Mueller, Murphy, O'Connor) Mass Unit: solar mass ☥

Thursday, October 11, 12
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Mass Unit: solar mass ☼

Thursday, October 11, 12
Physics of PPSN & PSN
(Talk: Woosley)

Star $> 80 \ M_\odot$
Physics of PPSN & PSN

(Talk: Woosley)

Star > 80 M☉
Physics of PPSN & PSN

(Talk: Woosley)

Star > 80 M☉
Physics of PPSN & PSN

(Talk: Woosley)

Star > 80 M⊙
Physics of PPSN & PSN

(Talk: Woosley)

Star > 80 M⊙

\[ \gamma < \frac{4}{3} \]

C/O
Physics of PPSN & PSN

(Talk: Woosley)

Star > 80 M☉
Physics of PPSN & PSN

(Talk: Woosley)

Star > 80 M⊙
Physics of PPSN & PSN

(Talk: Woosley)

Star > 80 M☉

150 M☉ > Star > 80 M☉
Physics of PPSN & PSN

(Talk: Woosley)

Star > 80 M⊙

? →

150 M⊙ > Star > 80 M⊙

E ~ 10^{52}+ erg

250 M⊙ > Star > 150 M⊙
How to Blow Up Multi-D Stars?

1D Models
80 - 150 M☉ Stars (Woosley+ 2007, priv. comm.)

CASTRO (SciDAC CAC PI: Woosley)
Massive Parallel, Adaptive Mesh Refinement (AMR), Multi-D, Radiation, Hydro+( Nuclear Burning, Rotation, GR, ... )

Supercomputers

Itasca Franklin Hopper Jaguar

Thursday, October 11, 12
Scaling Performance

CASTRO Weak Scaling on Jaguarpf

Now get your own CASTRO!!

Center for Computational Sciences and Engineering

Thursday, October 11, 12
Core of 110 M⊙ star

(cm/s)
Physical Properties of Colliding Shells
Physical Properties of Colliding Shells

Chen + in prep

3,000,000+ CPU Hours

Thursday, October 11, 12
Explosive Burning of 150 $M\odot$ Star
Explosive Burning of 150 M\(\odot\) Star
Core of 150 $M_\odot$ Star
Core of 150 M⊙ Star
Exploding 200 M☉ Star (2007 bi)
Exploding 200 M⊙ Star (2007 bi)
More Explosions!
(Chen+ in prep)

BSG 150

BSG 200

BSG 250

RSG 150

RSG 200

RSG 250

No Bang!! form a black hole

Thursday, October 11, 12
## Results

<table>
<thead>
<tr>
<th>Model</th>
<th>Mass [M(\odot)]</th>
<th>Core [M(\odot)]</th>
<th>(E) ([10^{52}\text{ erg}])</th>
<th>Ni [M(\odot)]</th>
<th>Instab.</th>
<th>Mixing</th>
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<tr>
<td>B150</td>
<td>150</td>
<td>67</td>
<td>1.29</td>
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Ni is only slightly mixed out.
The Gamma-Ray emission for PSNe is unlikely.
(Talk: Fruchter)
## Conclusion

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(Talk: Smartt)

Mass loss rate
(Talks: Arnett, Vink, Guzik, Fox, Shiode)
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<td>Multi-SN</td>
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<td>PSN</td>
<td>YES</td>
<td>Pop I(?) , II, III</td>
<td>Large Ni</td>
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<td>BH</td>
<td>No</td>
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*Talk: Smartt*

*Mass loss rate*

*(Talks: Arnett, Vink, Guzik, Fox, Shiode)*

*Talk: O’Shaughnessy*
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Mixing can alter the observational signature

(Talk: O’Shaughnessy)
19

Conclusion

80 ~ 150 \( M_\odot \)

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250+ \( M_\odot \)

Very Bright

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YES

No

Fate

PPSN

PSN

BH

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Mixing can alter the observational signature

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Talk:

O'Shaughnessy

Pop I, II, III

Pop I(?), II, III

No

Mass loss rate

(Talks: Arnett, Vink, Guzik, Fox, Shiode )

(Talk: Smartt )

Thursday, October 11, 12
Impact of the First Stars

Cosmological Impacts of the First Stars

Ke-Jung (Ken) Chen*, Myoungwon Jeon†, Thomas Greif‡, Volker Bromm*, & Alexander Heger∗


Abstract

The First Supernovae

The first stars synthesized the first heavy chemical elements beyond hydrogen and helium atoms, which are required to form later generations of stars and galaxies. The supernovae from the first stars produced large amounts of ionizing photons, which triggered the formation of the second generation of stars and galaxies. Our simulations show that the impact of the first stars on the surrounding gas was significant and could lead to the formation of the first galaxies.

Introduction

One of the most fundamental questions in modern cosmology is understanding the end of the cosmic dark age, when the first stars and galaxies transformed the simple early universe into states of ever-increasing complexity. The first galaxies comprised of the first elements of matter gravitationally bound in dark matter halos and are usually recognized as the building blocks of modern galaxies such as our Milky Way. In this paper, we discuss the role of the first stars and their feedback on the assembly of the first galaxies.

Recent simulations suggest the fragmentation of the first star-forming cloud may result in the formation of binaries or multi-star systems. In one of our scenarios, we assume the formation of a close binary with masses of 15 M⊙ and 8 M⊙ stars, with the latter forming a black hole and accreting matter from the 15 M⊙ star. This accretion can lead to the formation of massive stars, which in turn can lead to the first generation of galaxies. Compared with isolated stars, the binary has a higher efficiency to nucleate stars, which will be important for the history of cosmic star formation.

Cosmological Simulations including
1. Star Formation
2. Stellar Evolution
3. Radiative Transfer
4. Supernovae
5. Chemical Enrichment
6. Chemical Cooling
7. Binary Scenario

Collaborating with

Myoungwon Jeon
University of Texas

Thomas Greif
ITC, Harvard
Many thanks for your attention

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The Kavli Institute for Theoretical Physics
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M

SciDAC
Scientific Discovery through Advanced Computing

National Energy Research Scientific Computing Center

AAS

APS

YAU

SIGMA XI

The Scientific Research Society