

An approach to the construction of EOS Database

Chikako ISHIZUKA
(Tokyo Univ. of Sci.)

Research Theme

1. Liquid-Gas Phase Transition in SN environment
2. Hyperon EOS Table for SNe
3. Database for Metal Poor Star Observations (SAGA)

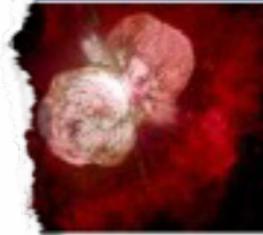
Outline of Today's Talk

1. Task at Group A03
2. Current Interests
3. Approach to the construction
EOS Database

EOS Information for SNe

| HOME | **EOS List** | Tools | Applicati

8 EOS tables (row data & codes)
 2 EOS tables coming soon
 4 Links to the other EOS tables



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Useful Links

[Our Group](#)[Our Project](#)

Shen EOS and its friends

• [1998 ver.](#)**constituents:**nucleons, alpha, a heavy nucleus**methods:**Relativistic Mean Field Theory

using parameter set TM1+Thomas Fermi calc.

physical constants:

m_u=931.49432[MeV],

hbarc=197.32705[MeVfm],

pi=3.14159265358979323846

ref.)Particle Data Book, PRD 50,3-1(1994) p.1233

comments:Original**articles:**[Nucl. Phys. A, 637 \(1998\) 435](#)**manuals:**[guide for EOS1.pdf](#)--main table = [eos1.tab.qz](#)--table for zero temperature = [eos1.t00.qz](#)--table for zero proton fraction = [eos1.Yp0.qz](#)• [2011 ver.](#)**constituencts:**nucleons, alpha, a heavy nucleus**methods:**Relativistic Mean Field Theory

using parameter set TM1+Thomas Fermi calc.

physical constants:

m_u=931.49[4MeV],

hbarc=197.327[MeVfm],

constituents,
 detailed info. of phys. const.,
 ref., EOS table data, manual

comments on the table
 e.g.) characteristics
 of used potential
 and cal. methods etc.

List up EOSs

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3rd - 5th, Dec, 2011 Ise, Shima, JAPAN

Tools for SN simulations

- Add lepton contributions, interpolate EOS tables
- EOS plot function **coming soon**
- Thomas-Fermi config. of inhom. phase (S. Yamamuro)
- Transform EOS tables from (Y_e, ρ_B, T) to (Y_e, S, T)

Future Works

- More EOS Tables (S.Furusawa, H.Togashi)
- Nucleosynthesis/Progenitor models
(N. Izutani, T. Yoshida, H.Umeda)
- Neutrino interactions (K. Sumiyoshi)

The following groups summarize the useful info. for SN simulations as well

http://cococubed.asu.edu/code_pages/codes.shtml

<http://www.stellarcollapse.org/>

<http://phys-merger.physik.unibas.ch/~hempel/eos.html>

<http://williamnewton.wordpress.com/links/physics-research/>

Background

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There are lots of works on nuclear EOS.

You can find about **300 papers** titled "EOS" in arXiv in this decade, while we have 15 EOS tables.

Lattimer-Swesty EOS, Shen EOS and their friends are still mainly used in astrophysical studies, nevertheless fine EOSs are NOT always tabulated.

 **What causes this situation?**

The answer is the cost of tabulating EOS for large grids.
We should be free from EOS tables...

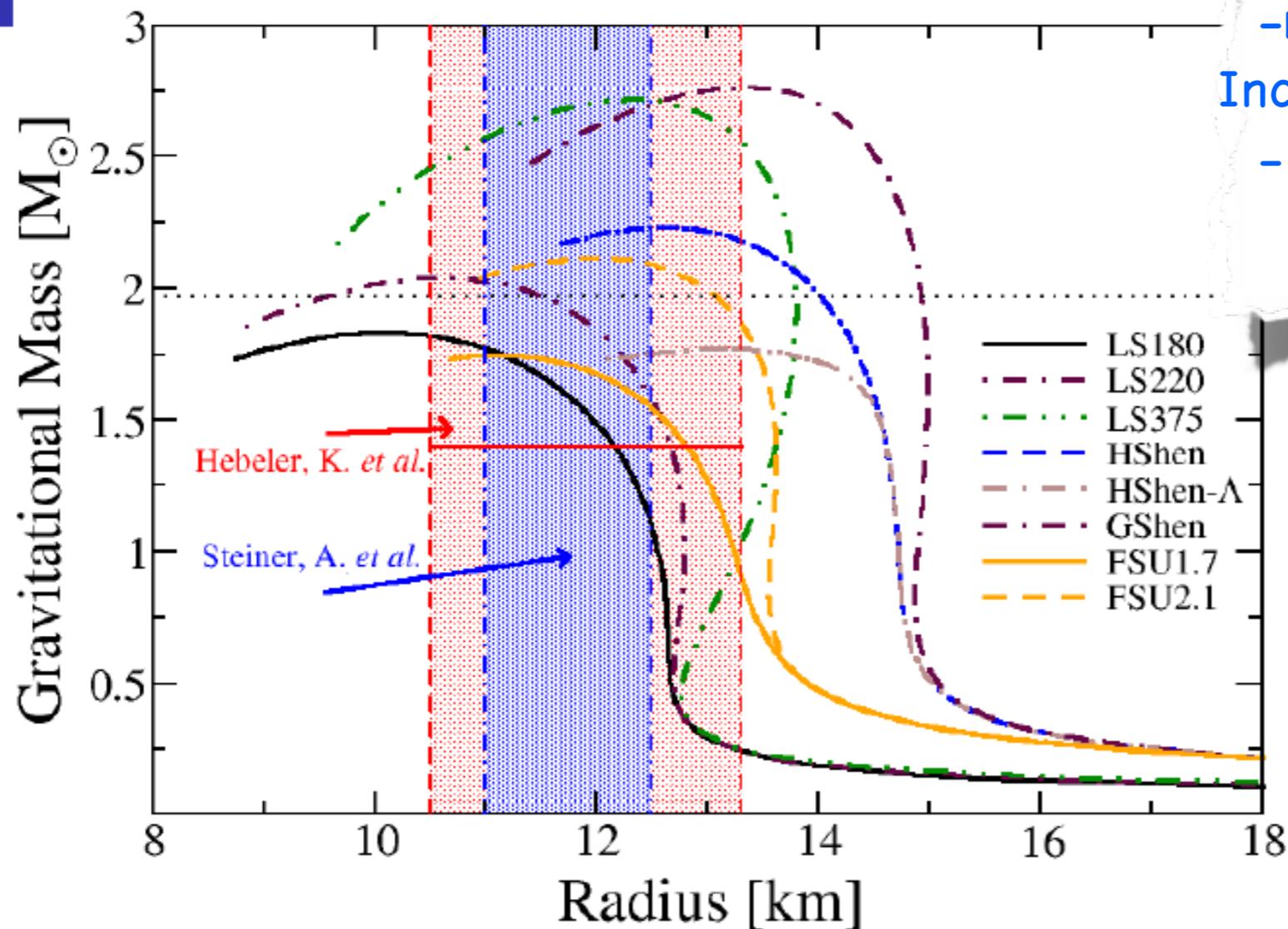
Worth constructing EOS DB!?

In addition to the above, exp. data and obs. data related to EOS are now increasing as shown in next slides.

EOS Problem from NS Obs.

- Recent problems of nuclear EOSs for compact objects
"The most of nuclear EOS proposed can not support 2Msum NS with strangeness or quarks"
- "MR relation derived from NS obs permit only LS EOS"
- Is that true? Why not?

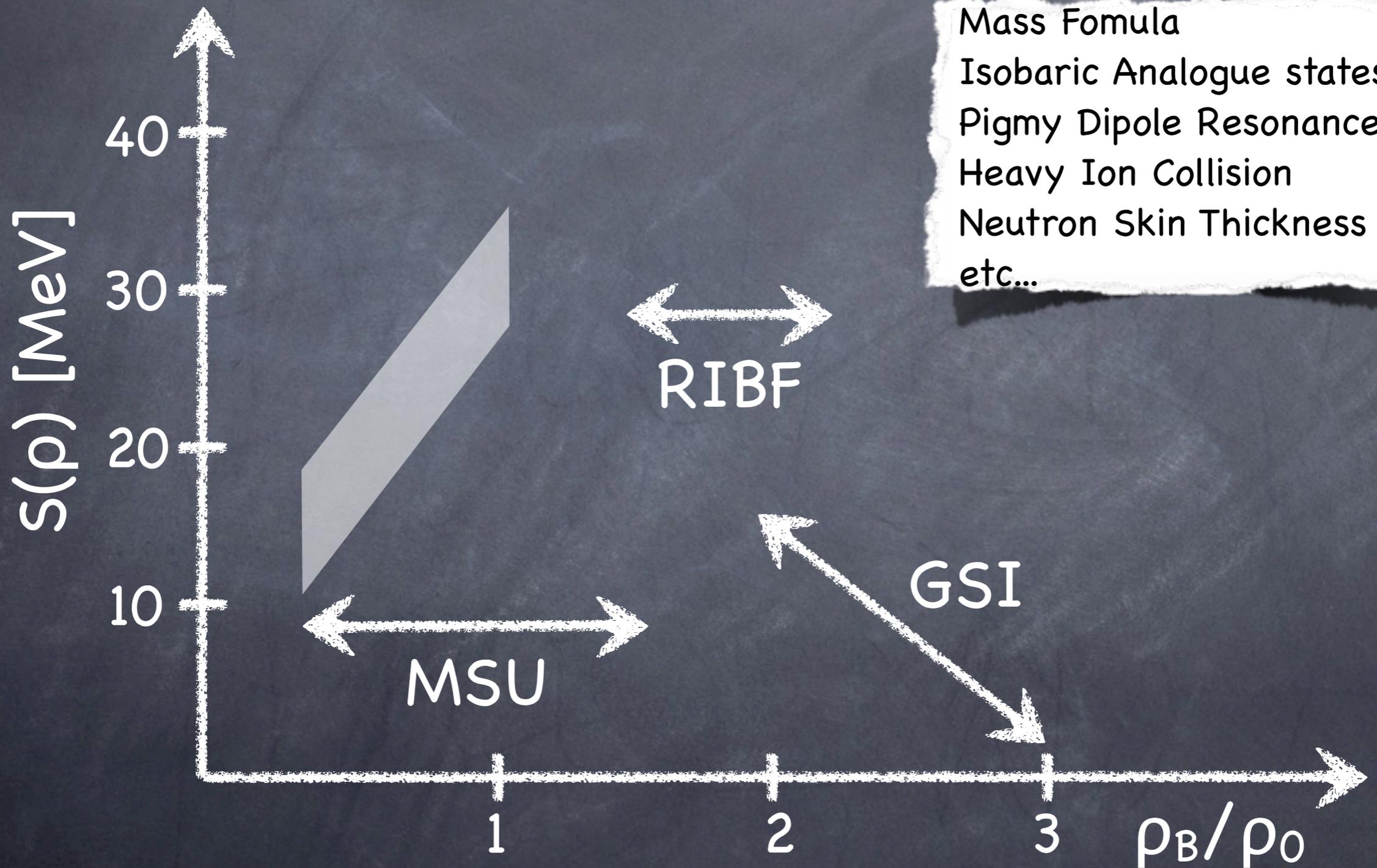
Neutron Matter and Mass Fit Symmetry Correlations



Obs. difficulty to decide R
-model dependent
Inconsistency with HIC exp.
- gamma 0.26 from NS Obs
0.35-1 (B.Tsang 2009)
density dep. of the sym. E

J. M. Lattimer
OMEG11

Constraints on EOS from nuclear physics



Mass Formula

Isobaric Analogue states

Pigmy Dipole Resonance

Heavy Ion Collision

Neutron Skin Thickness

etc...

An Approach to the Construction of EOS DB

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The point is...

How do we share these information on EOS,
NS obs. data and HIC exp. data?

What do we care about when we see these data?
e.g.) assumptions, physical conditions, calc.

In EOS DB, we categorize each EOS according to

- their theo. background such as framework for "high/medium/low" densities and/or temperatures...(1),
- "rel./non-rel."...(2),
- off course their framework such as LDM, HF, RHF etc...(3)

What Database can do is

SAGA -Stellar Abundances for Galactic Archeology Database-

(URL)<http://saga.sci.hokudai.ac.jp/wiki/doku.php?id=start/> (UK Mirror)<http://www.astro.keele.ac.uk/saga/wiki/doku.php>

Data Retrieval System for SAGA Database SAGA RETRIEVAL SYSTEM

Last update of database: 2010-03-16 18:01:16

* not working
** Other options do not work.

Query

Specify X and Y axis	<input type="button" value="search"/> <input type="button" value="example"/> * <input type="button" value="reset"/>
Xaxis	Category <input type="text" value="Li"/> (Fe/H) From: <input type="text"/> To: <input type="text"/> <input type="button" value="Include"/> data with upper limit
Yaxis	Category <input type="text" value="log-e"/> From: <input type="text"/> To: <input type="text"/> <input type="button" value="Include"/> data with upper limit
Criterion +	Category <input type="text" value="[X/H]"/> From: <input type="text"/> To: <input type="text"/> <input type="button" value="Include"/> data with upper limit
Additional criteria	Optional Criterion <input type="text" value=""/> Range <input type="text" value=""/>
Object	<input "0107"="" "cs",="" ,="" type="text" value="0107-5240"/>
Binarity	<input type="text" value=""/> To <input type="text" value=""/>
Magnitude	Band <input type="text" value=""/> : From <input type="text" value=""/> mag
Resolution	<input type="text" value=""/> < R < <input type="text" value=""/>
Author	<input type="text" value=""/> <input type="button" value="strict"/> <input type="button" value="forward agr"/> <input type="button" value="fuzzy"/>
Reference	<input type="text" value="ALL"/>
Publication Year	From <input type="text" value=""/> To <input type="text" value=""/>
Retrieval Options	
Display / Page	<input type="text" value="10"/>
Order by**	<input type="text" value="Object"/>
Output Option	<input type="text" value="single file"/>
Histogram Option	<input type="text" value="separated files"/> <input type="text" value="single file"/> <input type="text" value="histogram"/> Range <input type="text" value=""/> <input type="text" value=""/> (necessary for histogram)
Cross Search	<input type="text" value=""/> cross papers <input type="button" value=""/>
	<input type="button" value="search"/> <input type="button" value="example"/> * <input type="button" value="reset"/>

What Database can do is

SAGA -Stellar Abundances for Galactic Archeology Database-

(URL)<http://saga.sci.hokudai.ac.jp/wiki/doku.php?id=start/> (UK Mirror)<http://www.astro.keele.ac.uk/saga/wiki/doku.php>

Choose to plot this object

Links to quick preview files in HTML format

Atmospheric parameters adopted for each object and reference

Retrieved values and available data. Choose one datum if two or more data are available.

SAGA SEARCH RESULT

Results : 420

#	<input type="checkbox"/>	Object	Reference	[Fe/H]	Teff	logg	[Fe/H]	log-e(Li)
1	<input type="checkbox"/>	BD-09_4604	C.Charbonnel+,AAP,442,961,2005	-1.38	5660	4	<input checked="" type="radio"/> -1.38	<input checked="" type="radio"/> 2.121
2	<input type="checkbox"/>	BD-10_155	C.Charbonnel+,AAP,442,961,2005	-2.87	5008	3	<input checked="" type="radio"/> -2.87	<input checked="" type="radio"/> 1.018
3	<input type="checkbox"/>	BD-10_388	C.Charbonnel+,AAP,442,961,2005	-2.51	6287	3.85	<input checked="" type="radio"/> -2.51	<input checked="" type="radio"/> 2.257
4	<input type="checkbox"/>	BD-12_3709	C.Charbonnel+,AAP,442,961,2005	-1.34	5278	3	<input checked="" type="radio"/> -1.34	<input checked="" type="radio"/> 1.268
5	<input type="checkbox"/>	BD-14_5890	C.Charbonnel+,AAP,442,961,2005 B.W.Carney+,AJ,125,293,2003	-2.07 -2.01	4885 4840	3 2.1	<input checked="" type="radio"/> -2.07 <input type="radio"/> -2.01	<input checked="" type="radio"/> 1.025
6	<input type="checkbox"/>	BD-15_6355	C.Charbonnel+,AAP,442,961,2005	-1.83	6349	4	<input checked="" type="radio"/> -1.83	<input checked="" type="radio"/> 2.351
7	<input type="checkbox"/>	BD-17_6692	C.Charbonnel+,AAP,442,961,2005	-1.87	5065	3	<input checked="" type="radio"/> -1.87	<input checked="" type="radio"/> 0.911
8	<input type="checkbox"/>	BD-18_5550	M.Spite+,AAP,430,655,2005	-3.06	4750	1.4	<input type="radio"/> -3.06	<input checked="" type="radio"/> 0.75
			D.L.Burris+,ApJ,544,302,2000	-3	4575	1.4	<input type="radio"/> -2.93	
			R.Cayrel+,AAP,416,1117,2004	-3.06	4750	1.4	<input type="radio"/> -3.06	
			J.A.Johnson+,ApJS,139,219,2002	-2.9	4600	0.95	<input checked="" type="radio"/> -3.03	
			A.McWilliam+,AJ,109,2757,1995				<input type="radio"/> -2.91	
			J.Melendez+,ApJ,575,474,2002	-2.87	4683	1.7	<input type="radio"/> -2.87	
			T.V.Mishenina+,AAP,396,189,2002				<input type="radio"/> -3.01	
			T.V.Mishenina+,AAP,370,951,2001	-3.01	4600	0.5	<input type="radio"/> -3.01	
			M.Spite+,AAP,455,291,2006	-3.06	4750	1.4	<input type="radio"/> -3.06	
			S.M.Andrievsky+,AAP,464,1081,2007	-3.06	4750	1.4	<input type="radio"/> -3.06	
			J.A.Johnson+,ApJ,658,1203,2007	-2.89	4806	1.72	<input type="radio"/> -2.89	
			G.Bihain+,AAP,423,777,2004	-3.01	4668	1.5	<input type="radio"/> -3.01	
9	<input type="checkbox"/>	BD-20_6718	C.Charbonnel+,AAP,442,961,2005	-1.23	5064	3	<input checked="" type="radio"/> -1.23	<input checked="" type="radio"/> 0.953
10	<input type="checkbox"/>	BD-21_3420	R.Smiljanic+,ApJ,644,L121,2006	-1.04	5946	3.96	<input type="radio"/> -1.04	<input checked="" type="radio"/> 1.95
			E.Caffau+,AAP,441,533,2005	-1.04	5946	4.41	<input checked="" type="radio"/> -1.04	

previous next

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42																		

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What Database can do is

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(URL) <http://saga.sci.hokudai.ac.jp/wiki/doku.php?id=start/> (UK Mirror) <http://www.astro.keele.ac.uk/saga/wiki/doku.php>

Plot

* not working

GRAPH PLOT

Automatically generated clickable map

Mouse over pop up

Link to quick preview of each object

Display/hide data on plot

Link to numerical data

Delete from the list

Data	Legend	Size	Type*	Del*
1:	<input checked="" type="checkbox"/> MP	1	1	<input type="checkbox"/>
2:	<input checked="" type="checkbox"/> EMP,RGB	1	2	<input type="checkbox"/>
3:	<input checked="" type="checkbox"/> EMP,MS	1	3	<input type="checkbox"/>
4:	<input checked="" type="checkbox"/> Crich,RGB	1	4	<input type="checkbox"/>
5:	<input checked="" type="checkbox"/> Crich,MS	1	5	<input type="checkbox"/>
6:	<input checked="" type="checkbox"/> CEMP,RGB	1	6	<input type="checkbox"/>
7:	<input checked="" type="checkbox"/> CEMP,MS	1	7	<input type="checkbox"/>

Replot figure with changed setup

plot
reset

Title:

LEGEND

Left Top Right Top
 Left Bottom Right Bottom
 No Key Outside

LABEL

X:

Y:

Settings for figure

SCALE

X: Linear Logscale
 Y: Linear Logscale

Range

X Low: High:
 Y Low: High:

> or < *

Download Figures

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Download Data

download

Load upload files

Upload Data*

UpLoad

Input Data* plot reset

DATATYPE=

Download data and script to reproduce figure

Expected EOS discussion with EOS DB

Using our classifications,
we may find unknown aspects of EOS models
on the web as shown in the previous slide,
besides we can customize EOS for compact objects
within exp./obs. constraints by using EOS DB.

as a tool

(Lattice QCD, HIC exp. and NS Obs.)

+(Bayesian Analysis) = the most probable EOS

The EOS will allow us the following discussions;

1. Internal structure of NS from phenomenological Lagrangian by fitting the above EOS
(missing higher order effects or int. strength)
2. NS radius by OV eqn. and observed NS mass

physics #

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Compiled Object

Nucl. Theo. EOS/HIC Exp. SO, L/NS Obs.

Method

Database: MySQL+CSV

Search&Plot web system: Perl/cgi

Compilation by hand

Data

taken from papers (Fig./Tab./sentences)
with graph-read soft at present, however in future
to be provided from the authors of published papers

**"We need your kind cooperation
in constructing our EOS DB"**

Notations for symmetry energy

$$E(\rho, \delta) = E(\rho, 0) + E_{sym}(\rho)\delta^2 + o(\delta^4)$$

$$E(\rho, 0) = E(\rho_0, 0) + \frac{K_0}{2}\varepsilon^2 + o(\varepsilon^3)$$

$$E_{sym}(\rho) = E_{sym}(\rho_0) + L\varepsilon + \frac{K_{sym}}{2}\varepsilon^2 + o(\varepsilon^3)$$

$$K_0 = 9\rho_0^2 \left. \frac{\partial^2 E(\rho, 0)}{\partial \rho^2} \right|_{\rho=\rho_0}$$

$$\delta = (\rho_n - \rho_p) / \rho$$

$$\varepsilon = (\rho - \rho_0) / 3\rho_0$$

$$S_0 = E_{sym}(\rho_0)$$

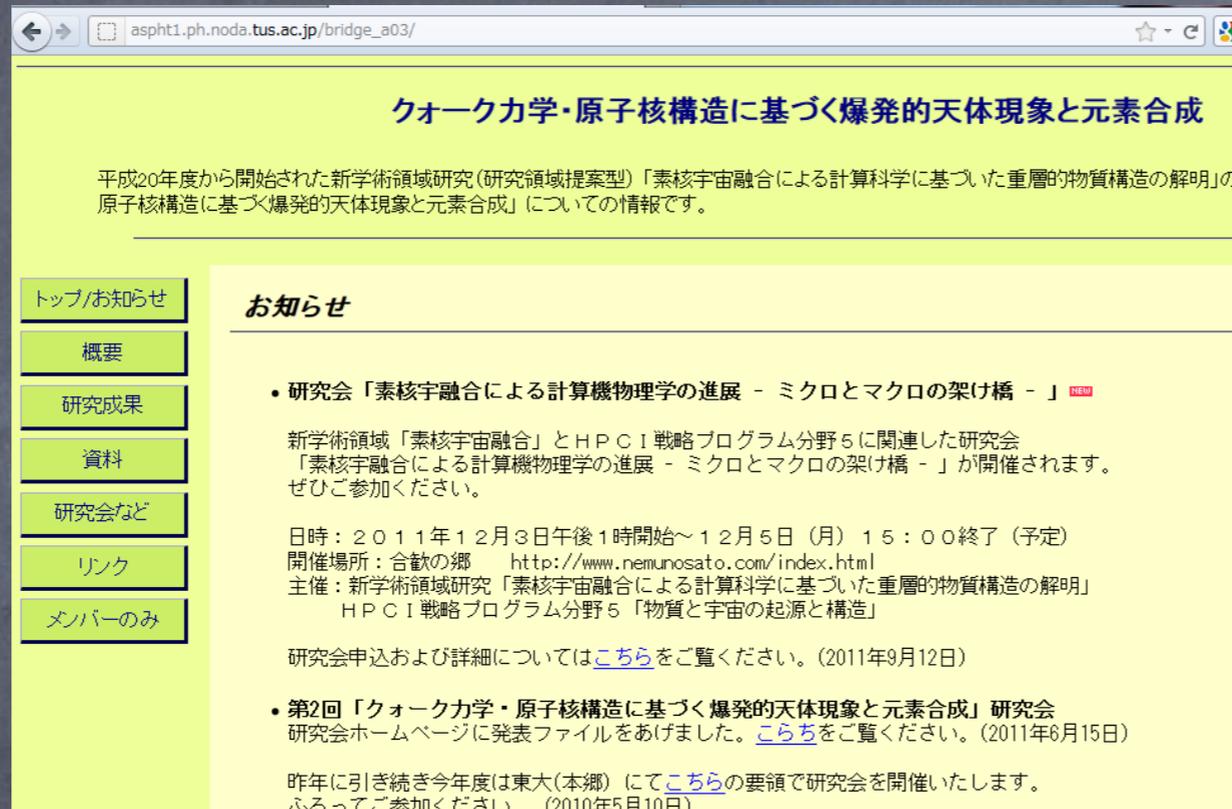
$$L = 3\rho_0 \left. \frac{\partial E_{sym}(\rho)}{\partial \rho} \right|_{\rho=\rho_0} = (3/\rho_0)P_0$$

$$K_{sym} = 9\rho_0^2 \left. \frac{\partial^2 E_{sym}(\rho)}{\partial \rho^2} \right|_{\rho=\rho_0}$$

$$K_\tau \approx K_{sym} - 6L$$

Task at Group A03 as an "web-master"

- Maintaining Group A03 webpages (Prof. Suzuki)



- Listing up EOSs (Prof. Sumiyoshi)

http://aspht1.ph.noda.tus.ac.jp/bridge_a03/EOS-index.html

ID: eosdb

PW: snmatter

List up EOSs

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Gathering EOS table

Summarising their theoretical background

e.g.) Physics constants, method...

/bridge_a03/EOS-index.html

SN2005E
Photo of a supernova from the Hubble space telescope.
Source: [Wikimedia Commons/NASA](#)

EOS Information for SNe

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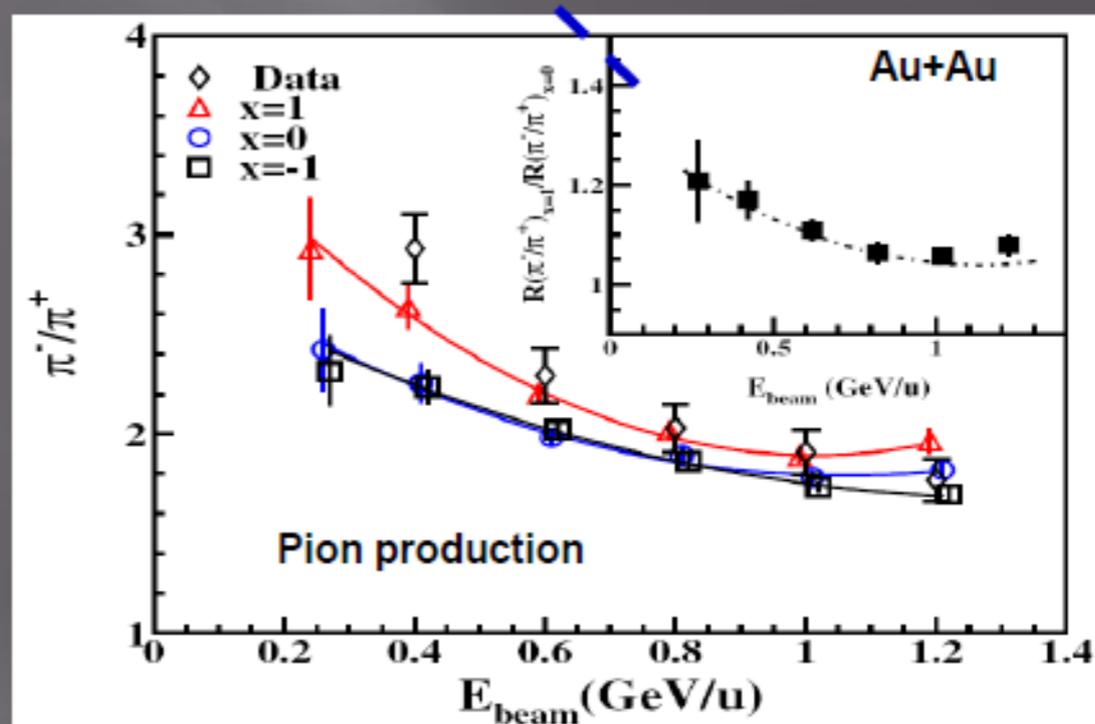
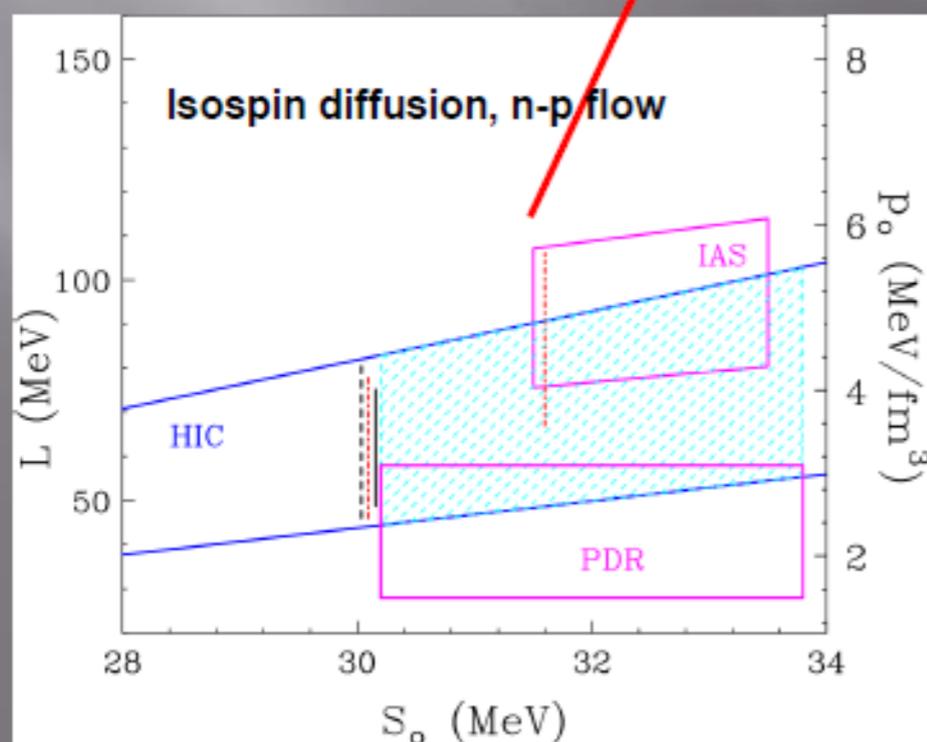
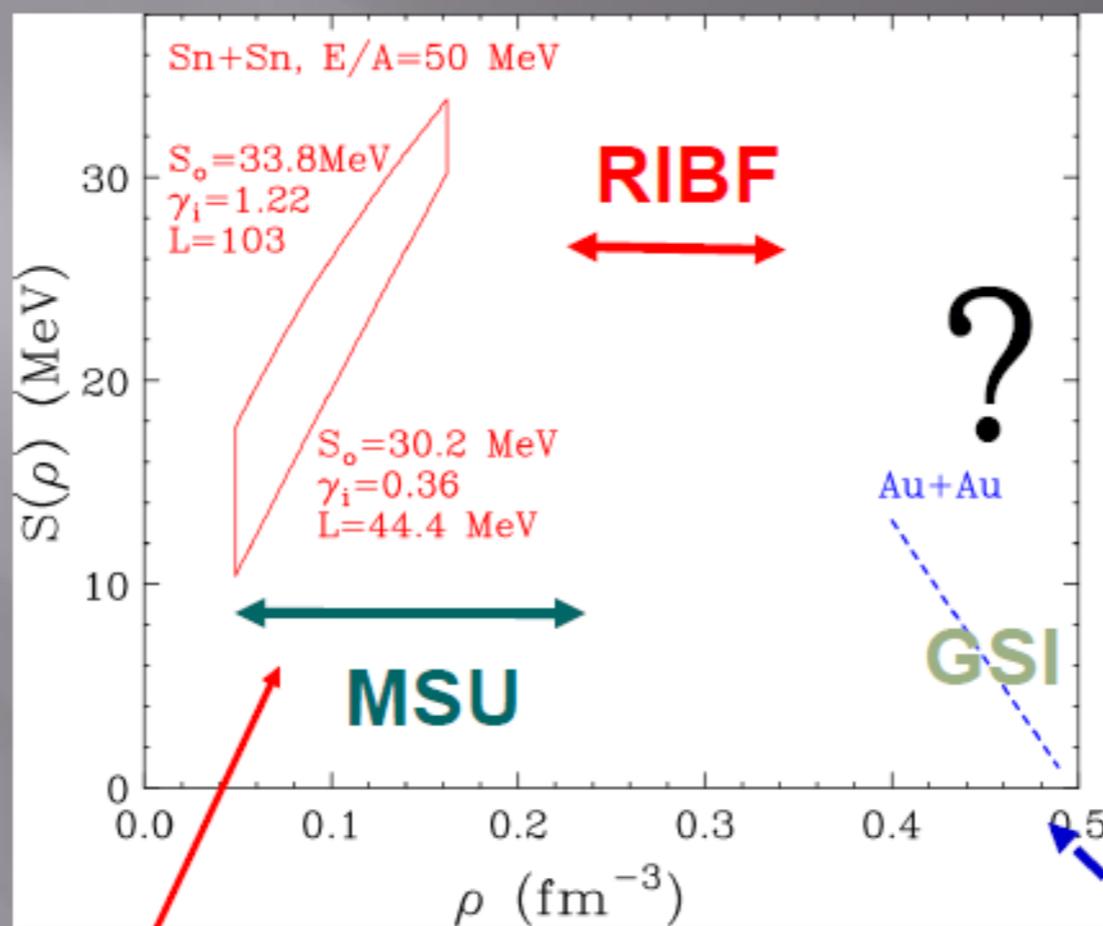
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Introduction

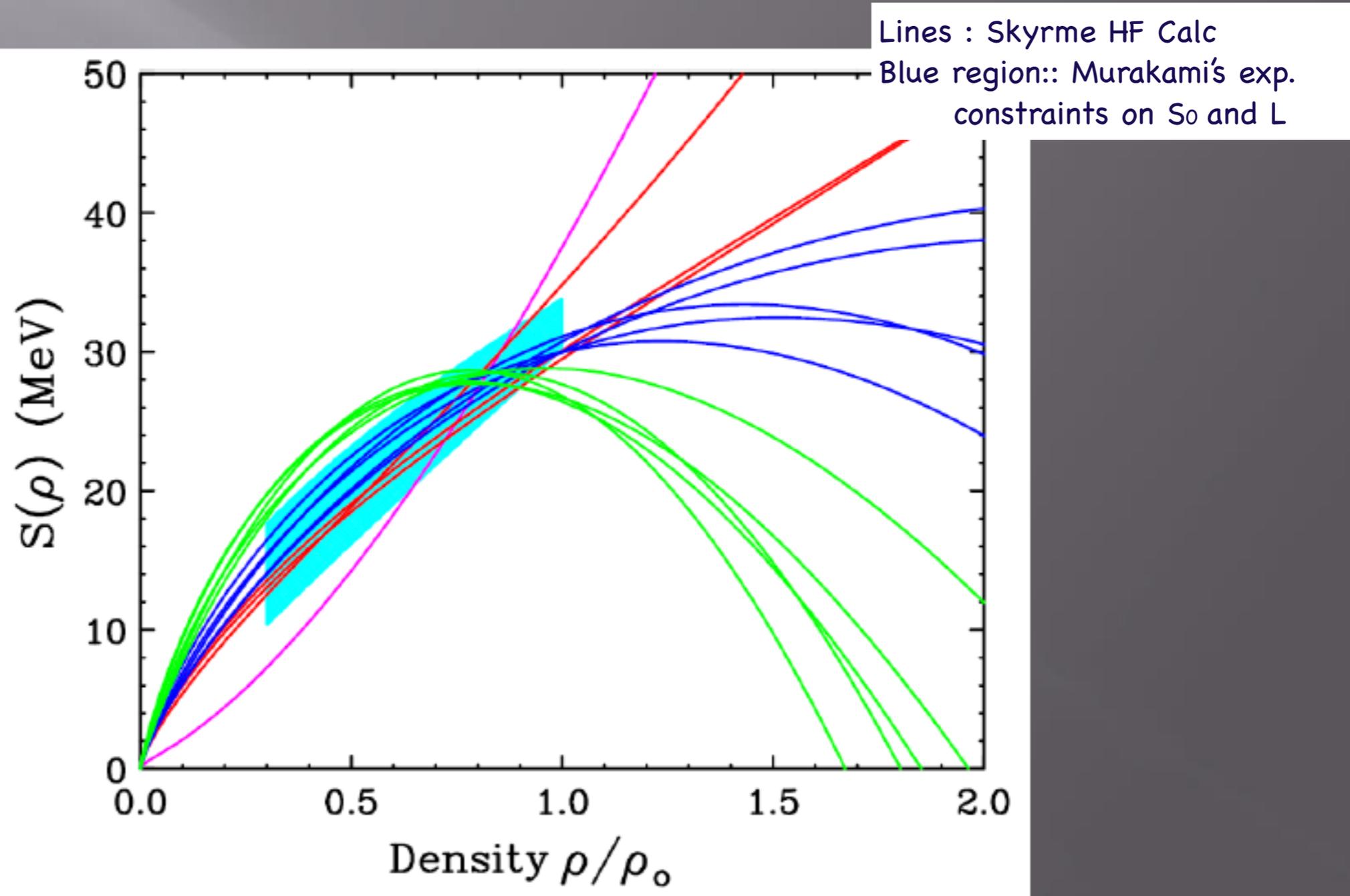
This web-site is managed by research programme A03 of Grant-in-Aid for Scientific Research on Innovative Areas "Elucidation of multirayered material structure based on computational science by the fusion of particle physics, nuclear physics, and astro physics". Our challenge is to understand various problems about the origin of matter such as element particle interactions, nuclear structures, and compact objects, within the great unified framework. We hope that our challenge would reach new research model not only to explain a heavy element nucleosynthesis mechanism and explosive phenomena but also to understand a complex material structure.

[More information about us](#)

News & Update Information



Xiao, et al., arXiv:0808.0186 (2008)
 Reisdorf, et al., NPA 781 (2007) 459.



Our consensus is $S_0=31-34$ MeV and $L=50-110$ MeV

Now preparing a summary article on outcomes of NuSYM11.

List up EOSs

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Tools for SN simulations

- Add lepton contributions, interpolate EOS tables
- Figure out EOSs **coming soon**
- Thomas-Fermi config. of inhom. phase (S. Yamamuro)
- Transform EOS tables from $(Ye, \rho B, T)$ to (Ye, S, T)

eos/EOS-tools.html

SN2005E
Photo of a supernova from the Hubble space telescope.
Source: Wikimedia Commons/NASA

EOS Information for SNe

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Add leptons' contribution to EOS

- add leptons and photon to Shen-style EOS tables
- [ep](#)
- [another fortran code to add leptons and photons](#)
- interpolation

EOS Plot

List up EOSs

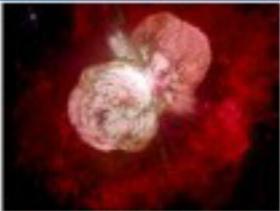
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eos/EOS-appendix.html

☆ ↕ ↻ nuc

EOS Information for SNe

SN2005E
Photo of a supernova from the Hubble space telescope.
Source: [Wikimedia Commons/NASA](#)



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Nucleosynthesis during SNe

Nucleosynthesis during SNe

Still under construction

Progenitor Models

We also provide you some progenitor models for supernovae. These models are calculated by Umeda Group at Univ. of Tokyo.

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This page is maintained by Chikako Ishizuka.
Last updated at 22nd. Sep. 2011

What SAGA can do is ...

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BPS CS22892-052: found in 18 paper(s).

QUICK PREVIEW OF DATA

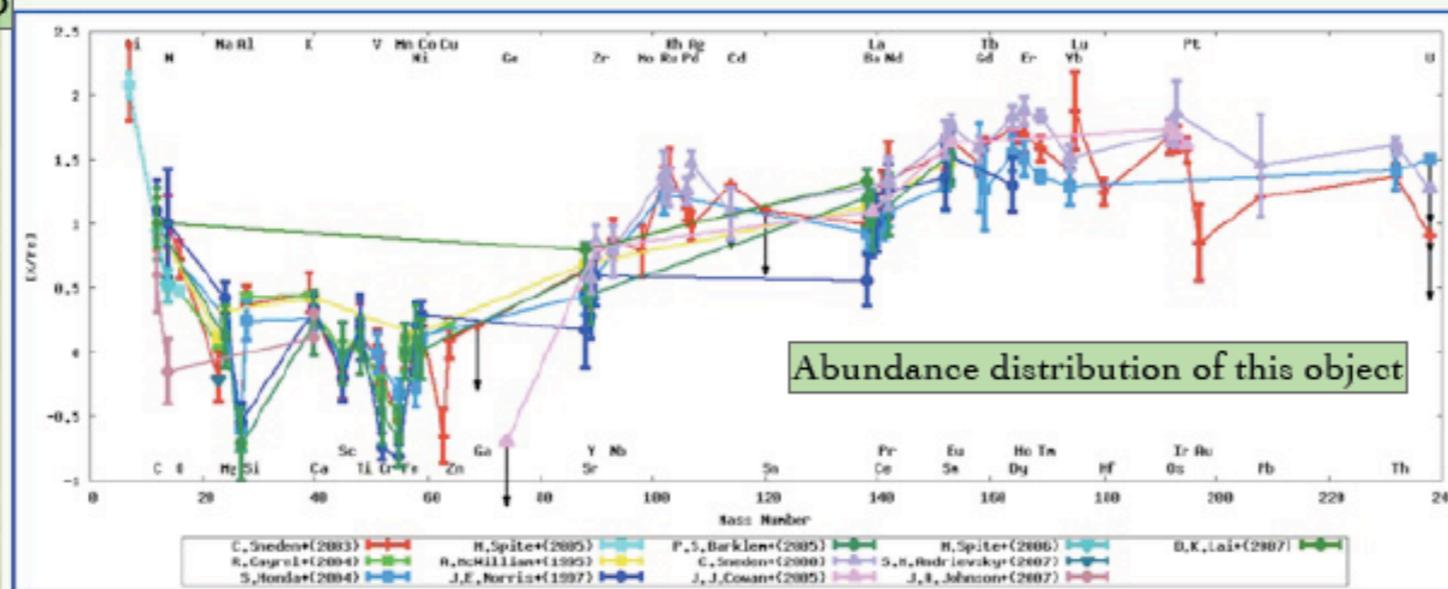
Labels:

[/C.Sneden et al.\(2003\)/](#) [/R.Cayrel et al.\(2004\)/](#) [/S.Honda et al.\(2004\)/](#) [/N.Christlieb et al.\(2004\)/](#) [/M.Spite et al.\(2005\)/](#) [/A.McWilliam et al.\(1995\)/](#) [/A.McWilliam et al.\(1995\)/](#) [/J.E.Norris et al.\(1997\)/](#) [/G.W.Preston and C. Sneden\(2001\)/](#) [/P.S.Barklem et al.\(2005\)/](#) [/C.Sneden et al.\(2000\)/](#) [/W.Aoki et al.\(2003\)/](#) [/J.J.Cowan et al.\(2005\)/](#) [/S.Honda et al.\(2004\)/](#) [/M.Spite et al.\(2006\)/](#) [/S.M.Andrievsky et al.\(2007\)/](#) [/J.A.Johnson et al.\(2007\)/](#) [/D.K.Lai et al.\(2007\)/](#)

Links to quick preview for this object

[Find this object in SIMBAD](#)

Link to SIMBAD



C.Sneden et al.,ApJ, 591, 936, 2003 (A0003,ADS)

Link to ADS

Atmospheric data

Link to quick preview for this reference

T_{eff} : 4800 $\log g$: 1.50 v_{turb} : 1.95 Stellar atmosphere parameters

Chemical Abundances

Element	Nline	[X/H]	[X/Fe]	log-e
Li I	...	-1.01+0.30	2.09+0.30	+0.15+0.30
CH	...	-2.22+0.10	+0.88+0.10	+6.30+0.10
CN	...	-2.09+0.20	+1.01+0.20	+5.83+0.20
O I	...	-2.38+0.15	+0.72+0.15	+6.45+0.15
Na I	...	-3.29+0.19	-0.19+0.19	+3.04+0.19
Mg I	...	-2.87+0.08	+0.30+0.08	+4.78+0.08
Al I	...	-3.68+0.15	-0.58+0.15	+2.79+0.15
Si I	...	-2.74+0.15	+0.36+0.15	+4.81+0.15

Legend:
 : Data presented in the paper
 : Data converted with the solar abundance from Grevesse et al. (1996)

Abundance data

and information on photometry, observing log, and binarity