

# Brainstorming on

**Compact objects, their equation of state, related explosive events, and their nucleosynthesis**  
*(a three day workshop in Basel, held jointly with working groups of the European COST Action NewCompStar)*

## **1. Present Understanding of Compact Objects**

White dwarfs, neutron stars, black holes and their maximum (and minimum) masses

## **2. The Role of the Equation of State**

The equation of state from subnuclear to supranuclear densities

## **3. Formation Processes of Compact Objects:**

Which processes as endpoints of stellar evolution lead to the formation of compact objects?

## **4. Explosive Events Involving Compact Objects Originating from Single Stars:**

Core-collapse supernovae, faint and superluminous supernovae, hypernovae/gamma-ray bursts

## **5. Explosive Events Involving Compact Objects in Binary Systems:**

Novae, type Ia supernovae, X-ray bursts, superbursts, neutron star mergers, neutron star – black hole mergers, black hole mergers

## **6. Nucleosynthesis Results from such Explosions and Observational Constraints:**

Nucleosynthesis predictions, their dependence on EoS input, constraints from the direct observation of such explosions, indirect constraints from galactic evolution

## Rationale

The Basel nuclear and computational astrophysics group has organized for a number of years a biannual so-called “brainstorming and fun“ meeting which brings together a number of collaborators, discussing the status and open problems in stellar objects, their evolution, explosions, and nucleosynthesis in relation to nuclear physics issues entering these topics.

In 2016 we intend to have a special focus on the role of the nuclear equation of state and its impact on the nucleosynthesis of these environments, which all involve compact objects or their formation processes.

This includes observational features, the nuclear equation of state itself, as well as relativistic/gravity aspects, and has therefore connections to the NewCompStar COST. Nevertheless we also want keep the overall focus of previous brainstorming and fun meetings, which is the nucleosynthesis of such events.

***This meeting is not meant as a typical conference or workshop with extended talks. Even in the talk sessions we intend to have presentations not longer than 15min (including questions; stating status, open problems, and possible ways for solutions).***

***In the following extended discussion sessions everybody can voice his/her point of view and/or show a slide with major evidence of results. This way we hope to come to conclusions in the joint and parallel working group meetings for laying out the path for research in the future.***

# Technical Aspects

As this is a meeting held jointly with working groups of the COST Action NewCompStar, participants who are members of this COST Action can be supported by it. But the meeting is intended also beyond the NewCompStar boundaries in the tradition of the Basel brainstorming (and fun) meetings with participants being specialists in the topics addressed in general, plus our partners from the Helmholtz Nuclear Astrophysics Virtual Institute (NAVI) and the SNF Scopes program for cooperations with Eastern Europe.

**Based on NewCompstar and funding of the Basel group all meals and local costs will be covered, in order to make things inexpensive. But the NewCompStar members have to pay their hotel expenses first, which will then be reimbursed. The hotel bills of the other participant will be covered directly by the organizers. There exist additional means for supporting participants further, if needed.**

**The detailed program follows below. We have 48 outside participants plus the members of the Basel group.**

# Schedule

Thursday

14:00-15:00 **talks on:** Stellar evolution and the formation of compact objects (WD, NS, BH),  
*general evolution of massive stars, formation of WDs and s-process, evolution with rotation, evolution in binary systems*  
(Hirschi, Pignatari, Georgy; **chair Leibundgut**)

15:00-16:30 **talks on:** EoS and compact objects  
*all aspects related to the physics of compact objects*  
(Burgio, Rios, Typel, Drago, Yudin, Iosilevskiy; **chair Hempel**)

16:30-17:00 coffee break

17:00-19:00 **talks on:** Core collapse of massive stars, the formation of neutron stars, black holes, and accompanying nucleosynthesis in such explosions,  
*explosion mechanism, multimessenger aspects, nucleosynthesis, spherical approximations*  
(Janka, Kotake+Kuroda, Hix, Pan, Martinez, Fröhlich, Rauscher; **chair Thielemann**)

20:00 Joint Dinner at Schnabel

<http://www.restaurant-schnabel.ch/start.html>

Friday

8:30-8:45 core collapse continued *magneto-rotational supernovae* (Kondratjev)

8:45-9:45 **joint discussion:** *on EoS of compact objects plus its effect on nucleosynthesis in CCSNe and hypernovae/GRBs*  
**by all; chairs Oertel/Typel**

# Schedule

9:45-10:30 **talks on:** (Explosive) Events in binary systems  
*X-ray bursts, type Ia supernovae, neutron star/compact object mergers*  
(Langer, Reichert/Cabezón, Röpke; **chair Janka**)

10:30-11:00 coffee break

11:00-12:00 **talks on:** Explosive events in binary systems  
*continuation*  
(Travaglio, Rosswog, Wu, Hotokezaka; **chair Janka**)

12:00-12:45 **joint discussion:** on these objects and their nucleosynthesis  
**by all (chair Rosswog)**

12:45-14:00 lunch break

14:00-14:30 **joint discussion:** continued

14:30-16:00 **talks on:** Constraints from  
*(a) observations (chair Nadyozhin)*  
(Leibundgut, Diehl, Mashonkina, Mishenina, Sitnova, Martinez)

16:00-16:30 coffee break

16:30-17:00 **talks on:** Constraints from  
*(b) galactic chemical evolution (modelling)*  
(Kobayashi, Wehmeyer; **chair Diehl**)

17:00-18:00 **joint discussion:** on observations and chemical evolution  
**by all (chair Diehl)**

19:30 Aperó and Dinner at Löwenzorn

<http://www.loewenzorn.ch/>

# Schedule

Saturday

9:00-10:15 **Parallel meetings of groups on**

(a) *the EoS and compact objects*

(convenors **Vidana + Hempel**)

(b) *other nuclear/neutrino physics aspects affecting explosive events*

(convenors **Martinez + Panov**)

(c) *nucleosynthesis and its impact on galactic evolution*

(convenors **Kobayashi + Mashonkina**)

10:15-10:45 coffee break

10:45-11:30 report by conveners of groups (a)-(c)

11:30-12:15 **final general discussion:** on open questions and future directions of the topics of this workshop (chairs **Vidana + Thielemann**)

**and discussion of the NewCompStar White Paper**

12:15 wrap-up and farewell