EXPLORING THE UNIVERSE FROM MICROSCOPIC TO MACROSCOPIC SCALES

Research Data Management in ELEMENTS

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Spokespersons:

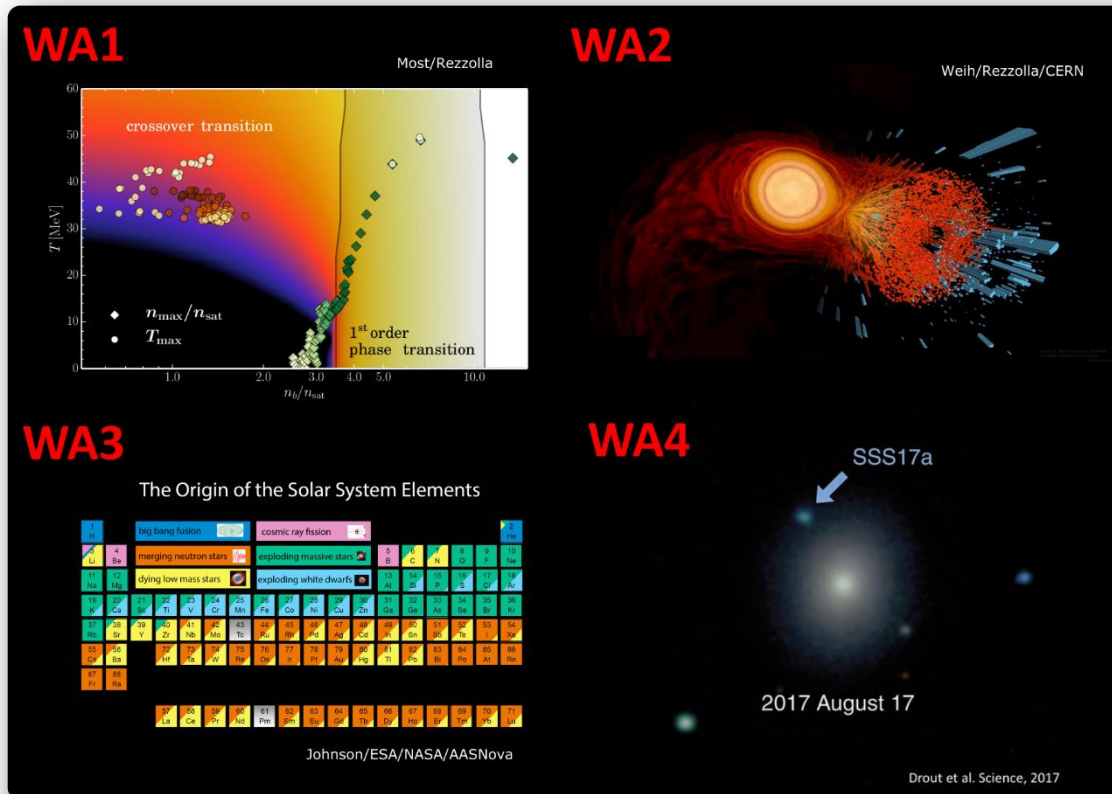Prof. Dr. Luciano Rezzolla (GU Frankfurt)

Prof. Dr. Dr. h.c. mult. Norbert Pietralla (TU Darmstadt)

Research in ELEMENTS

... addresses the physics of gravity, hadrons, nuclei, and atoms with
numerical simulations and accelerator-based experiments.

*From microscopic dynamics
to the equation of state (EOS)
of dense nuclear matter*

*From collisions of heavy ions
to collisions of neutron stars*

*Nucleosynthesis of
heavy elements*

*Electromagnetic signals
from compact stars*

Research in ELEMENTS

Macrophysics:

- Gravitational waves

- Lightcurves and nucleosynthesis

Microphysics:

- Matter under extreme conditions
- Nuclear and atomic reactions

Infrastructure:

- Particle accelerators
  - GSI/FAIR & S-DALINAC

GSI/FAIR

S-DALINAC/TU Darmstadt

What are research data?

DFG (as of December 21, 2021):

"Research data includes **measurement data**, **laboratory values**, audiovisual information, texts, survey or **observation data**, methodological test procedures and questionnaires. Compilations, **software and simulations** can equally represent a central result of scientific research and are therefore also included under the term research data."
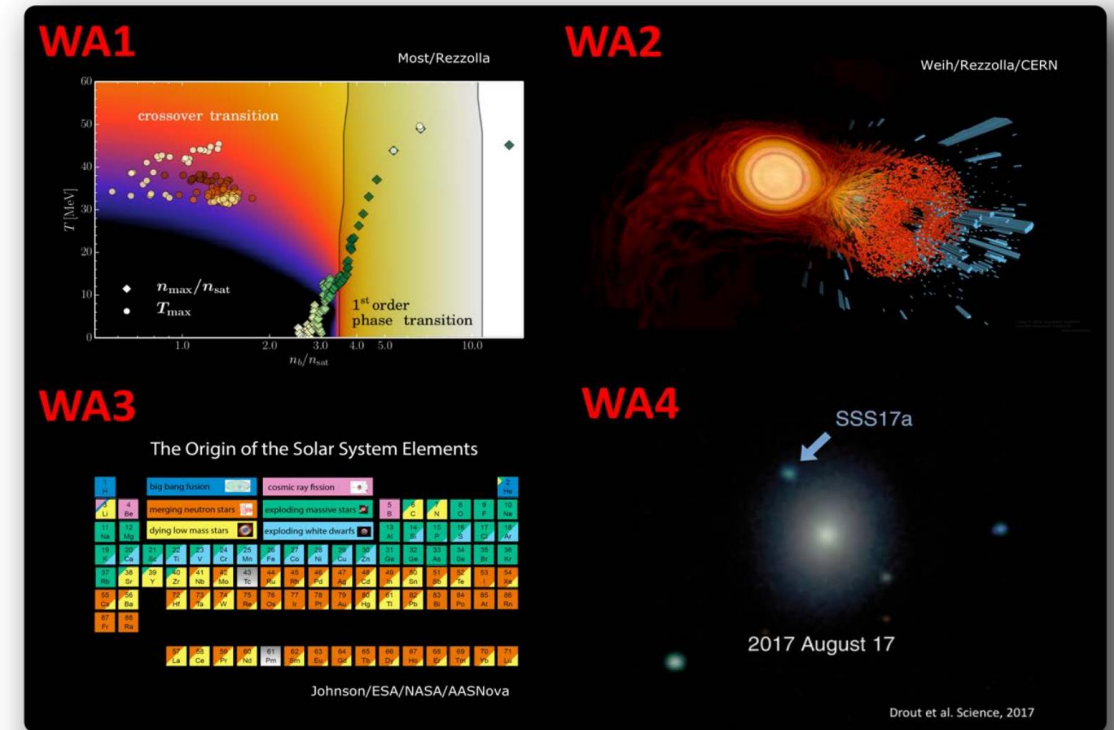
Research data in ELEMENTS

Expected generated data very diverse

- measurement of raw data /signals (experiments with stable & unstable, astronomical observations, ...)

- calculation of observables with different theoretical approaches (chiral EFT, NS EOS, lattice QCD, ...)

- analysis software (Python, C++, ROOT, ...)

- visualization of data (nuclear spectra, EOS, ...)

diverse projects with huge differences in data formats, processing, data sizes and storage requirements

Why would/should we care about RDM?

- enhance attention & visibility of own research

- accessibility & reproducibility of research results

- interdisciplinary research & meta analyses

- **DFG (as of March 14, 2022): "It will now be mandatory for proposals to include details."**

- "No data set is perfect and self-explanatory"

- good documentation & instructions to specific data and metadata

- crucial to accurately interpret results and their origin (from processing, analysis, and modeling)

"data and metadata entropy"
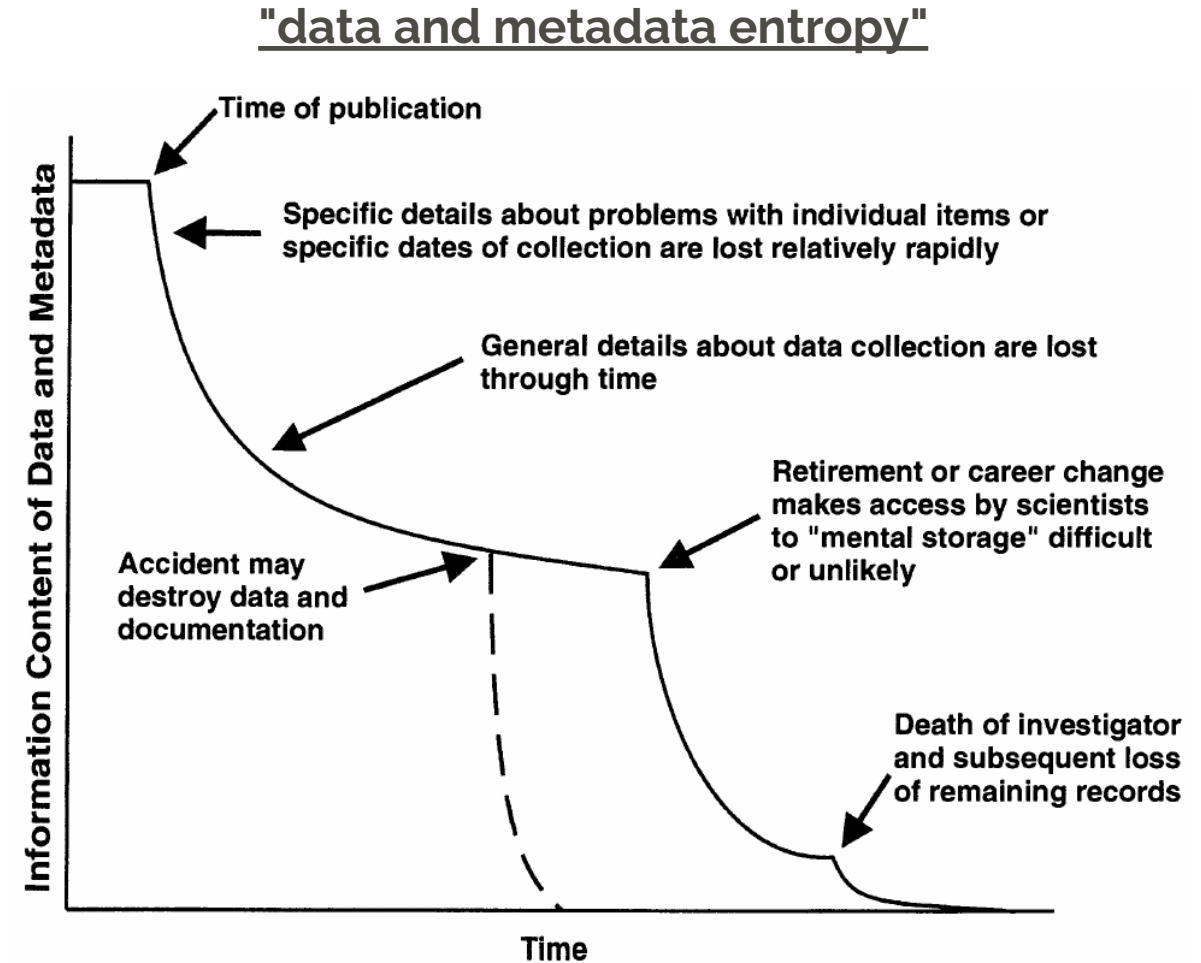
W. K. Michener et al., Eco. App. **7** (1997) 330-342.

FAIR data principles

Data and metadata should be ...

F indable — easy to locate, both by humans and by computer systems

A ccessible — archived long-term and made available in such a way that they can be easily retrieved

I nteroperable — available in such a format that it can be exchanged, interpreted and combined in a (semi-)automated manner with other data

R eusable — well described to ensure that it can be reused and properly cited for future research

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

TECHNISCHE UNIVERSITÄT DARMSTADT

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

GSI

Data management plan (DMP)

https://tudmo.ulb.tu-darmstadt.de/

- systematically deal with your research data from the very beginning!

- important to make your data interpretable and reusable for later time; also for third parties

- similar platform: Goethe-RDMO (https://rdmo.server.uni-frankfurt.de/)

- DFG-funded software RDMO

- collaboratively create and maintain a DMP

- numerous export options, e.g., for applications and reports

- being continuously further developed

Institutional repository of TU Darmstadt

TU | ULB | TUdata

https://tudatalib.ulb.tu-darmstadt.de/

- structured storage of research data and descriptive metadata (at least 10 years)

- publication of metadata and files including DOI assignment

- rights and role management

- TUdata provides 2 TB / year (free of charge) for each PI of ELEMENTS

- additional long-term archiving for 250 EUR per TB for 10-years archiving

Open Access

- Publications in ELEMENTS currently under evaluation by UB Frankfurt and ULB Darmstadt

- Challenge: How and where to publish Open Access? GU Frankfurt, TU Darmstadt, JLU Giessen and GSI?

Coordination between all institutions/universities necessary!

Training & education in RDM

- regular training to raise awareness for RDM

- introductory to RDM policy & common RDM tools

- "good RDM from the very beginning..."

- train students in RDM at early stage of their studies

- implement RDM in the curriculum

- theoretical basics and practical application of methods and tools
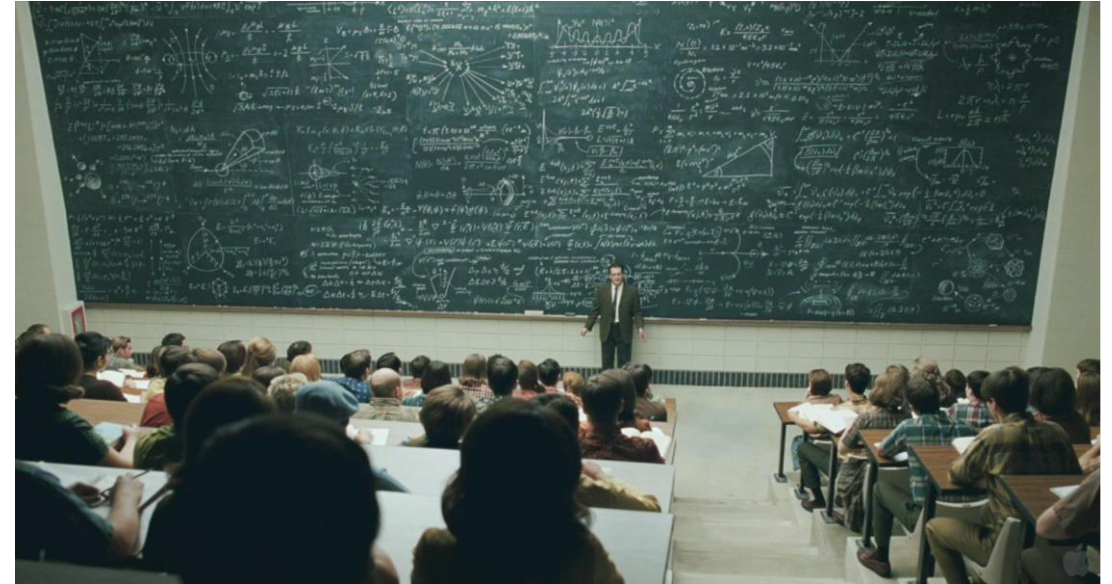
Screenshot from a scene of "A serious man", 2009.

Make sustainable RDM common practice!

Challenges for RDM in ELEMENTS

Towards a coherent RDM concept in ELEMENTS for the EXC application

- classify and standardize research data
- define common coherent data structures
- standardize metadata

- discussions within & between individual projects & work areas
- surveys on status and needs

- establish RDM plans and quality measures
- raise awareness for research-data handling
- training of ECRs in RDM policies and tools

- establish collaborations to other RDM projects
- develop training material & courses for ECRs
- implement RDM in curriculum at an early stage

- legal requirements & management
- transfer of research data to repositories

- use of existing platforms and support (tudata, tudatalib, re3data.org, …)

Networking with other RDM initiatives in progress

National research data infrastructures (NFDI)

- DFG intitiative to establish (inter)national coordinated network of consortia (currently 19)

NFDI consortium of particle, astro-, astroparticle, hadron and nuclear physics

Hessian research data infrastructures (HeFDI)

- supports RDM activities at Hessian universities
- partly in collaboration with NFDI consortia

NFDI4Ing represents the engineering community.

Digital Research Data at TU Darmstadt (TUdata)

- supports all members of the university in RDM

Collaboration with Goethe-RDM team and to GSI