Denkschrift 2025

J. Wilms

Astronomy Strategy Process

German astronomy: long-term strategy defined by “Denkschrift”-Process

- 1962: path towards ESO, ESA, Effelsberg, Calar Alto
- 1987: centralization of observing towards ESO, funding for VLT instrumentation and exploitation of space experiments: Verbundforschung @ BMBF and DLR
- 2003: ELT, SKA, ESA-missions, neutrino-, gamma- and gravitational wave astronomy; career development

Denkschrift 2017

- Denkschrift 2017
  (www.denkschrift2017.de)
  - good summary of status in 2017
  - major recommendations:
  - ground based facilities:
    - large facilities: support ELT instrumentation, German membership in SKA, access to Northern sky
    - medium: NOEMA, CTA, Europ. Solar Telescope

Denkschrift 2017

- Denkschrift 2017
  (www.denkschrift2017.de)
  - good summary of status in 2017
  - major recommendations:
  - space based facilities:
    - support of ESA cosmic vision (Athena, LISA, smaller missions [Euclid, PLATO,...]
    - continued support for SOFIA
    - national space program: support for technology development, bilateral programs, DLR Verbundforschung

Denkschrift 2017

- Denkschrift 2017
  (www.denkschrift2017.de)
  - good summary of status in 2017
  - major recommendations:
  - theory:
    - national computing infrastructure
    - Big Data, Data-Mining, Virtual Observatory

Denkschrift 2017

- Denkschrift 2017
  (www.denkschrift2017.de)
  - good summary of status in 2017
  - major recommendations:
  - astronomy and society:
    - career paths in astronomy
    - further strengthen equal opportunity efforts
    - strategic hiring: exoplanets, solar physics, instrumentation
    - lack of a ``Helmholtz-like'' astro institute...

International Context

Europe: Astronet (2007ff; 2023)
(mainly funding agencies)

- Extreme conditions in the cosmos
- Formation and evolution of galaxies
- Formation of stars and planetary systems
- Sun and solar system

Europe:
(mainly fundin

- Extreme
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- Formatic
- Sun and

What is the nature of dark matter and dark energy?	Are there deviations from the standard theories and models (general relativity, cosmological model, standard model of particle physics)?	What are the properties of the cosmic microwave background, first stars, galaxies and black holes in the Universe?
How do galaxies form and evolve, and how does the Milky Way fit in this context?	What are the progenitors of astronomical transients?	What physical and chemical processes control stellar evolution at all stages, from formation to death, and how?
What are the necessary conditions for life to emerge and thrive? Are we alone?	How do planets and planetary systems form and evolve?	What is the impact of the Sun on the heliosphere and on planetary environments?
What are/were the characteristics and habitability of various sites in the solar system, such as Mars or Jupiter's icy moons?	What is the origin of cosmic rays of all energies?	How can extreme astrophysical objects and processes probe new fundamental physics?

International Context

Europe: Astronet
(mainly funding agencies)

- Computing & data management
- ground: ELT, SKA + CTA, EST
- space: Athena, LISA
- lab astrophysics
- sustainable astronomy

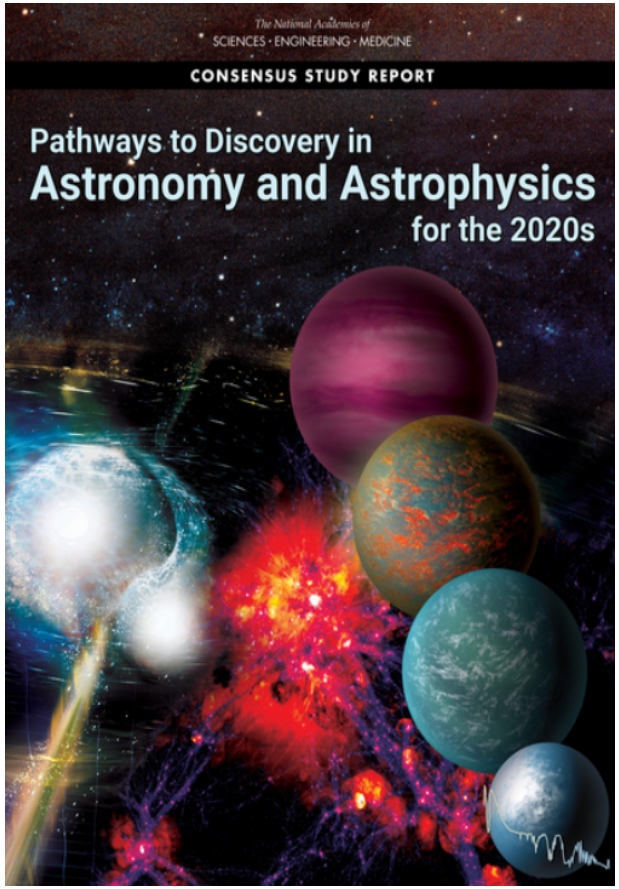
collaboration w/astroparticle (neutrinos, gw)

International Context

USA: Decadal Reviews
(1964, 1972, 1982, 1991, 2001, 2010, 2021)

Science themes:

- Worlds and Suns in context
  formation and evolution of stars & planets, habitability
- New Messengers and New Physics
  multimessenger and multiwavelength time domain astronomy
- Cosmic ecosystems
  modeling stars, galaxies and their formation and evolution

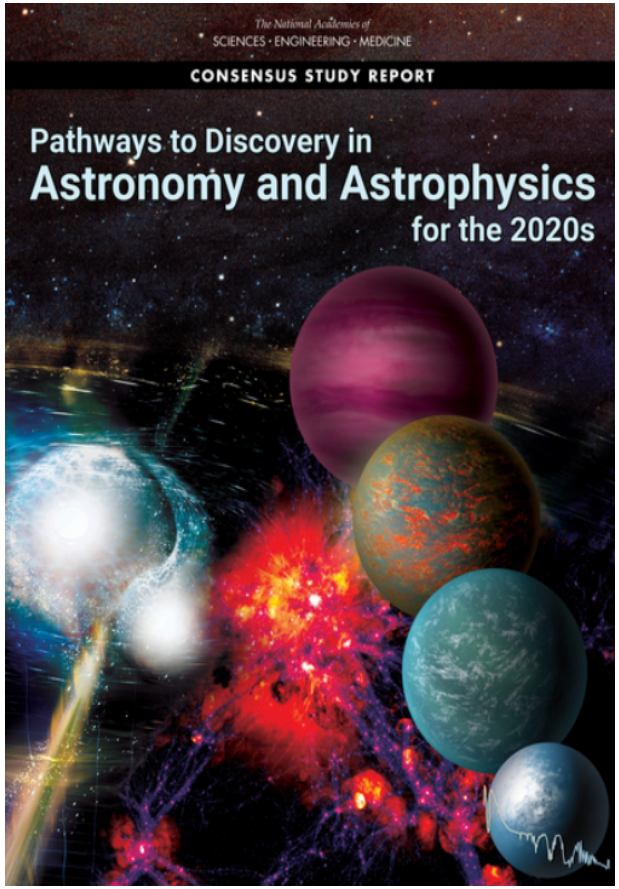


International Context

USA: Decadal Reviews
(1964, 1972, 1982, 1991, 2001, 2010, 2021)

Main recommendations:

- ground: 20-40m telescope (GMT, TMT), CMB stage4 observatory, ngVLA
(also mentions IceCube-Gen2, but outside remit)
- space: 6m IR/O/UV space telescope; IR or X-ray probe



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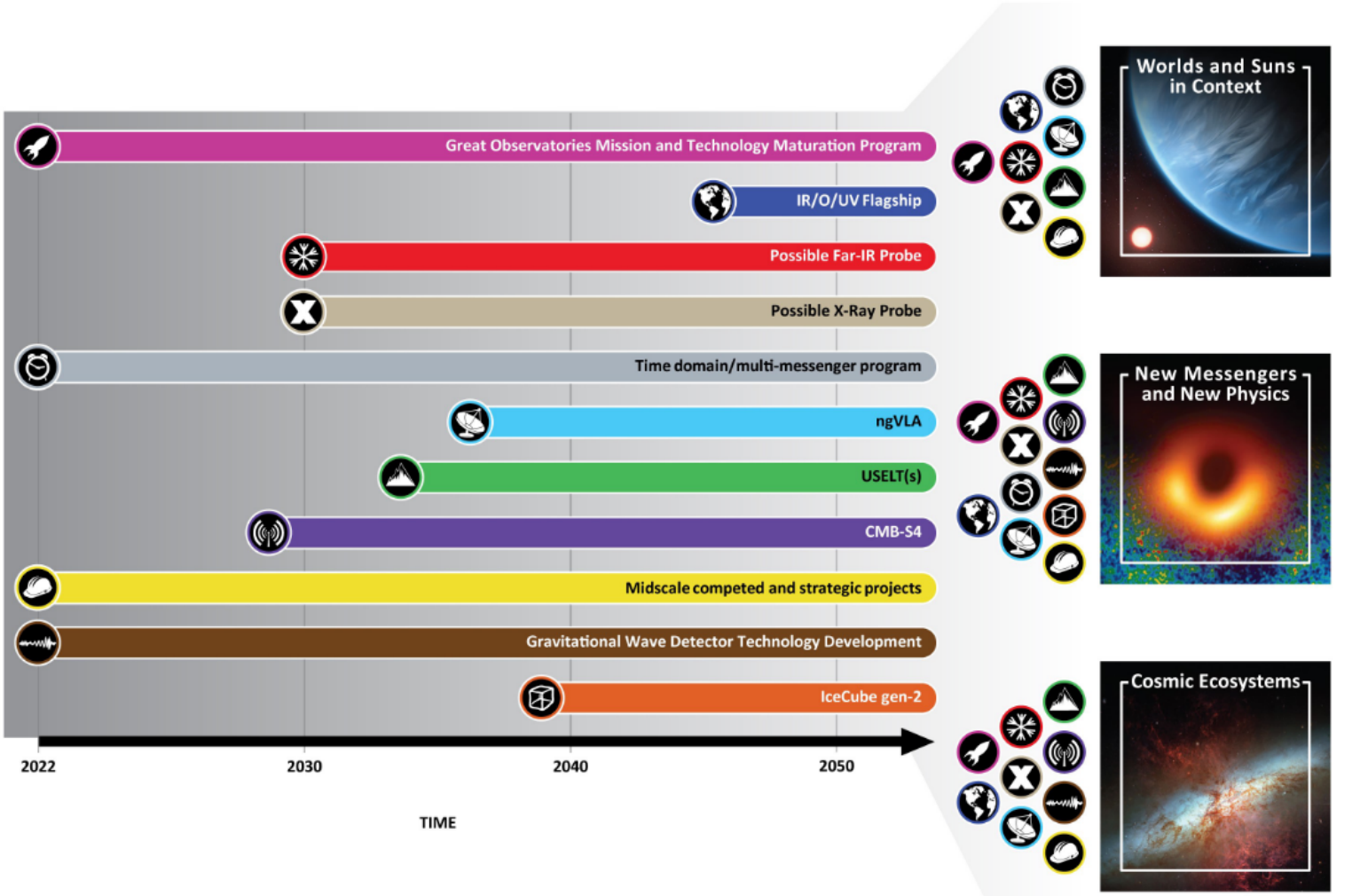

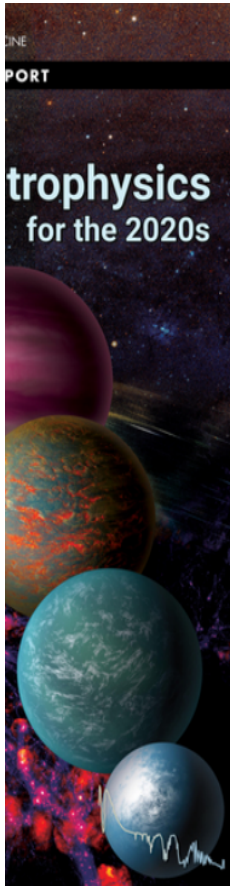

Changes since Denkschrift 2017

- DZA has been approved as new astronomical center
- SKA: German membership secured
- CTA will be observatory
- NFDI, ErUM-Data established, importance of open data approach also realized by politics
  FAIR principles, open source,... [many of which were common in astro before]
- Einstein Telescope is an ESFRI structure
- SOFIA cancellation: FIR now without instruments
- *new*: German solar physics endangered
- Astronet 2022-2035, APPEC roadmap, ESFRI roadmap
  https://www.astronet-eu.org/?page_id=521
  https://www.appec.org/
  https://roadmap2021.esfri.eu/
- US Decadal 2020
  https://www.nationalacademies.org/our-work/decadal-survey-on-astronomy-and-astrophysics-2020-astro2020

Consequence: *update* of German astronomical strategy to take this into account: *Denkschrift 2025*

Consequence of Changes

Need to identify:

- areas in existing Denkschrift which do not require large changes
  (e.g., ELT/ESO instrumentation, space [but changed timelines for L-class, budgetary constraints], most subjects of “Verbundforschung”)
- New topics, e.g.,
  - Gravitational wave *astronomy*
    (importance of EM follow up, astrophysics of sources)
  - IR post-SOFIA
    (balloons, small satellites,...?)
  - DZA
  - Astronomy and society: Green Astronomy, sustainability, societal impact of astronomy [and STEM as a whole], technology transfer, WissZeitVG...

Further Steps: Science

Work on update of existing Denkschrift:

- Coordination: M. Kramer, S. Walch, *J. Wilms*
- work w/existing Denkschrift, update/rewrite text directly
  (so no white papers)
- General approach:
  - update science case first
  - instrumentation: derived from updated science case
  - astro and society: new and important topic

Science Working Groups

- Stellar Astrophysics
  (coord: Geier/Roth)
- Planetary Systems and Habitability
  (coord Rauer/Reiners/Poppenhaeger)
- Circuit of Cosmic Matter
  (coord: Sasaki/Wolf)
- Milky Way and Local Group
  (coord: Walcher et al.)
- Galaxies and AGN
  (coord: Kadler/Foerster-Schreiber)
- Cosmology, Large Scale Structure, and young universe
  (coord: Reiprich/Komatsu)
- Extreme conditions in the cosmos, fundamental astrophysics
  (coord:Tjus et al.)

NOTE: no separate multimessenger physics - science should be addressed by above SWGs!

Infrastructure Working Groups

- Instrumentation (led by F. Eisenhauer)
  - Radio/mm
  - Optical/IR (incl Sun)
  - UV
  - TeV
  - Space (all wave bands)
  - Time-Domain Astronomy (all wave bands)
  - Multimessenger Facilities
- Laboratory Astrophysics

Infrastructure Working Groups

Setup in progress:

- Computing with subgroups:
  - HPC
  - Research Data, VO
- Astrostatistics / Data Science
- Astronomy and Society with suggested subgroups:
  - Transfer of Knowledge (“Technology Transfer”)
  - Astronomy and STEM education
  - Astronomy and the Public
  - Protection of the electromagnetic spectrum
  - Careers
- Statistical Data on German Astronomy

Timeline

- Jan/Feb 2024: Science and Instrument Working Group Inputs received
- March 2024: Currently condensing SWG input into updated strategy
  (J.Wilms [single point of failure...], Michael Kramer, Steffi Walch-Gassner, RDS exec)
- early April: Distribution of Science and Instrumentation *draft* to community
- 29/30 April 2024: Community meeting, Telegrafenberg (Potsdam)
  (discuss draft, balance contents)
- after that: Astro & Society, computing, etc.
- Sept 2024 (AG Cologne): Content presentation

Some observations

- SWG inputs show:
  - multiwavelength astro extremely common
    (not surprising)
  - multimessenger astro used where appropriate
    (neutrinos, some gw for stellar evolution)

  => generic mm/mw SPP proposal would be too unspecific to be successful

General (private) Denkschrift observations

Common themes in Input so far:

- main instrumental priorities in RDS community: ELT/VLT, SKA and ESA (M, L)
  (push for radio activities is also strong, also contributions, e.g., NASA [Habex, probes])
- smaller scale instrumentation efforts to enable leadership in flagships
  (have significant activities also at universities; note: increased project management effort poses challenge [DZA?])
- importance of theory, computing, data science
  (virtual institutes, perhaps led by DZA?)
- Fiscal realities should not be ignored:
  - flat budgets will be a success (Ukraine, Art 109 GG [Schuldenbremse],...)
  - danger of additional FAIR cost overruns
  - ESO procurement approach has changed, further increasing costs
  - WissZeitVG adds uncertainty for keeping expertise around