



## Insight-HXMT in Tübingen

Andrea Santangelo 安圣杰

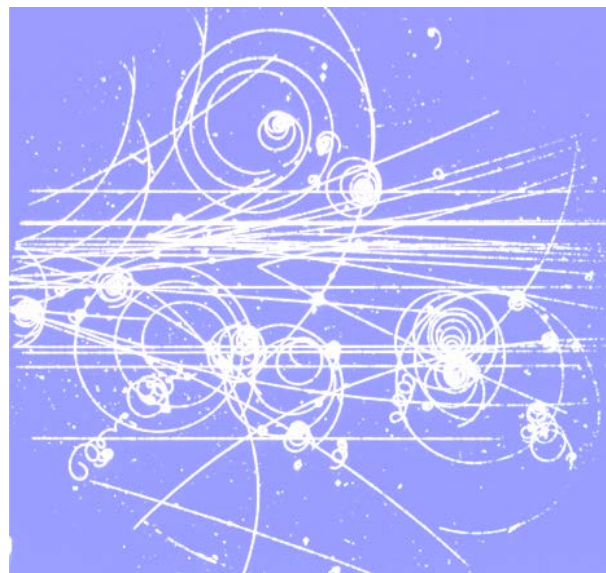
The second Joint workshop on Insight-HXMT calibration and science, Beijing  
11-13.04.2018



## Astronomy and Astrophysics



## Particle Physics



*Discover new particle in the laboratories and in the Universe*

*Relation between the elementary composition of matter and the large scale structures of the Universe*

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Astrophysik



Teilchenphysik



**Observational and  
Experimental Astrophysics**

*A. Santangelo, K. Werner, B. Stelzer*

**Theoretical Particle Physics**

*T. Gutsche, H. Reinhardt, W. Vogelsang, B. Jäger*

**Theoretical Astrophysics**

*W. Kley, K. Kokkotas, R. Kuiper*

**Experimental particle physics**

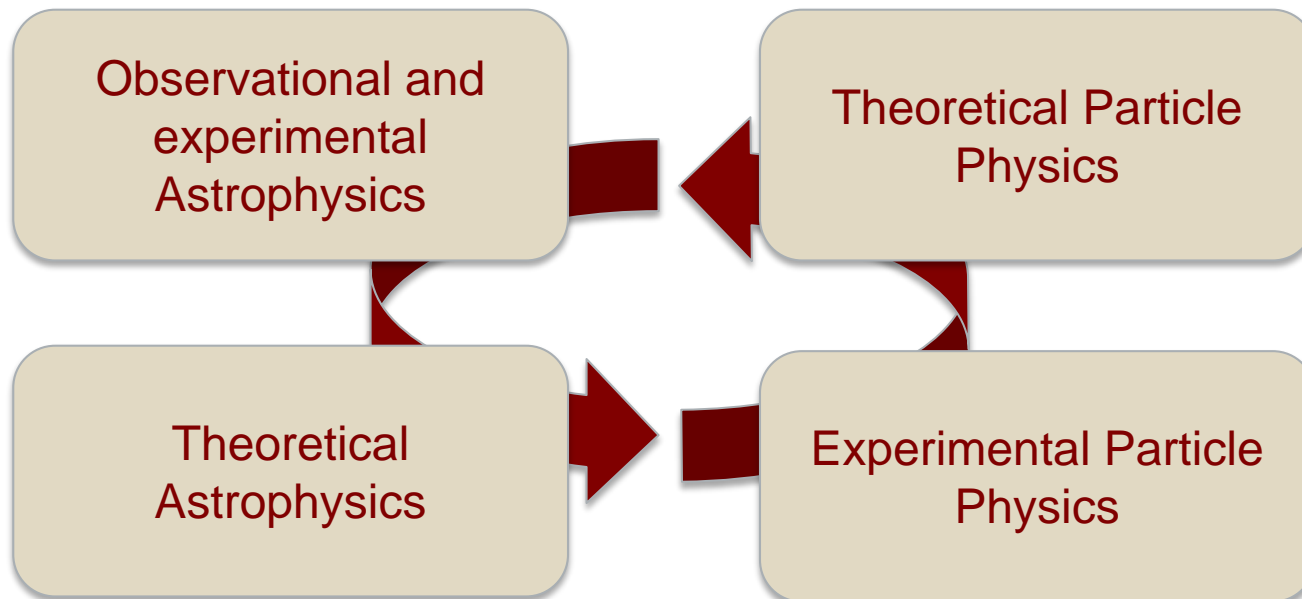
*J. Jochum, T. Lachenmaier, H.R. Schmidt*

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*The Institute of Astronomy and Astrophysics is part of the Kepler Center.*

Collaboration of the Institute of Astrophysics and Particle Physics to coordinate research in theory and experiments, and education



**From WS 2017/2018:**  
**International Master in Astro and Particle Physics**

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Tübingen is *one of the oldest Universities* in Germany, Astronomy in 1511 (J. Stöffler)



From *Topographia Sueviae*, (1643)

## *Michael Mästlin*

The Golden Ratio “more or less 1,6180340”, *Catalogue of the Pleiades*, *Observations of Mars and Juppiter*

1550-1631



# Perhaps the most famous student



Joh. Keplerus

1571-1630



## Divided in four sections (*Abteilungen*)

At the “Sand” Campus



*Klaus Werner*

UV and Optical



*Andrea Santangelo*

High Energy  
Astrophysics  
*(incl. TeV Astr.)*

At the main Campus



*Kostas Kokkotas*

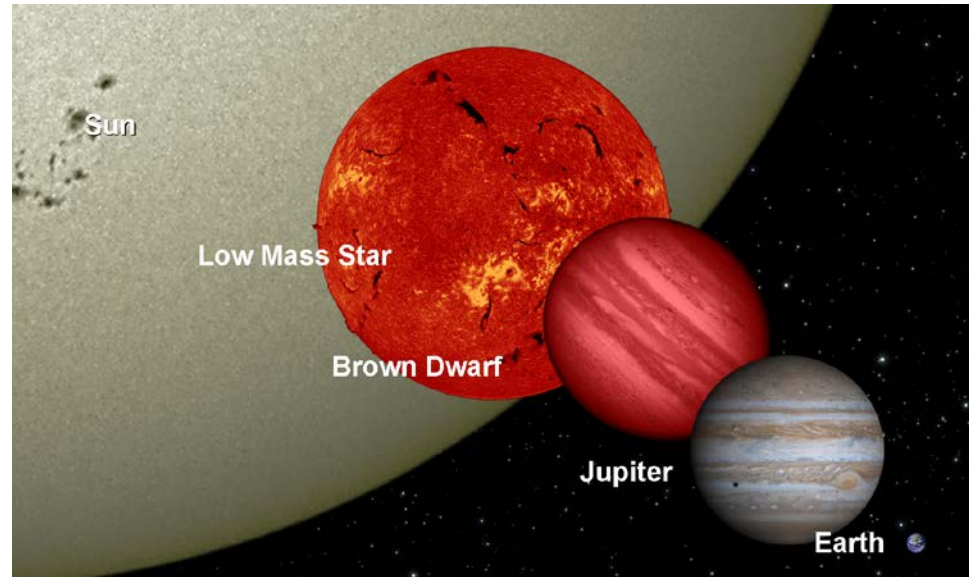
Theoretical  
Astrophysics



*Willy Kley*

Computational  
Astrophysics

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*Beate Stelzer*

Space-based observational Astrophysics

*Dr. Rolf Kuiper*

Emmy Noether Research Group  
on Massive Star Formation at the  
University of Tübingen





# The Sand Campus

- Our Building Sand 1, two floors (incl. Laboratories for Electronics)
- Observatory

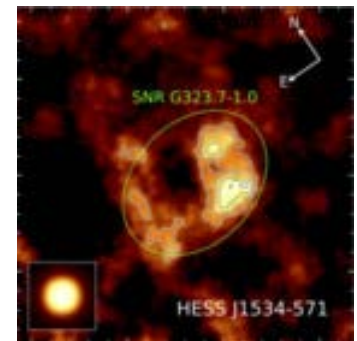
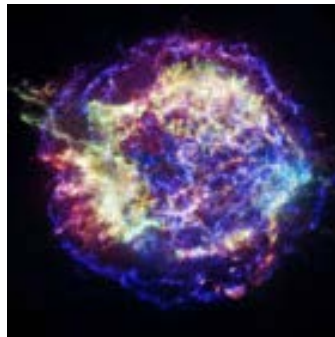
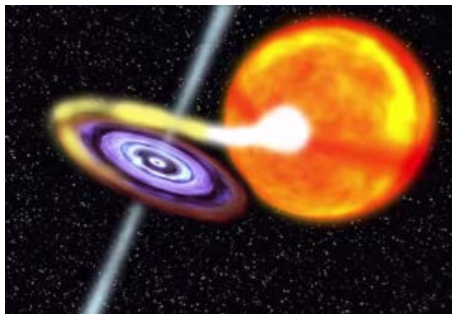


- Machine Workshop (precision mechanics)
- Mirror testing facility (TeV astrophysics)
- 80 cm Telescope, didactic and small research projects



# High Energy Astrophysics

Prof. Andrea Santangelo





High Energy Astrophysics: *Exploration of the Universe in the energy range from X-rays to Ultra High Energies.*

## Space Based X-Gamma Ray Astrophysics

**DFG**

***Analysis &  
Interpretation  
Neutron Stars, Black  
Holes, SNR, ISM...***



Projekträger im DLR

***Experimental  
Hardware, Mission  
Development,  
Simulations***

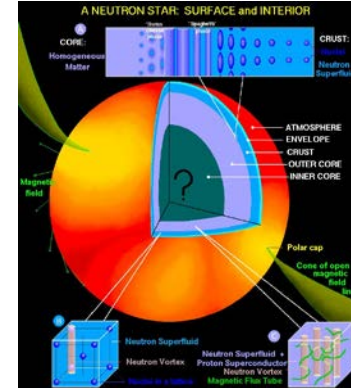


Projekträger im DLR

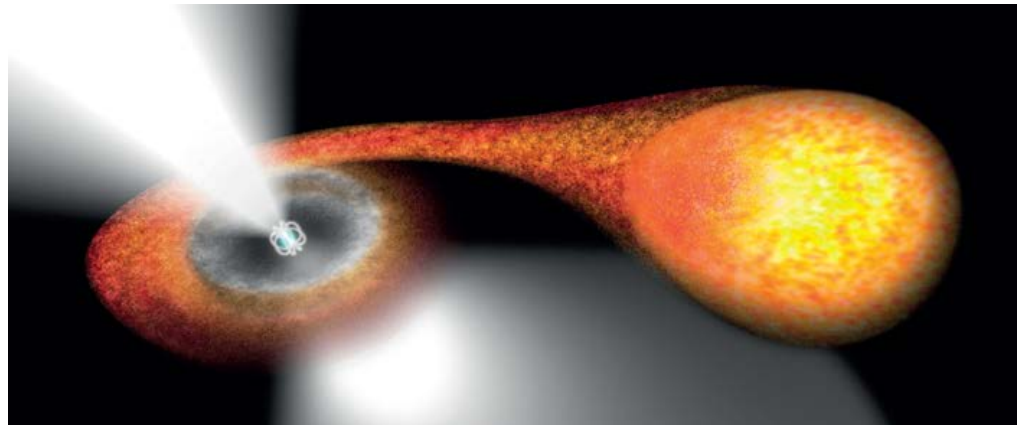
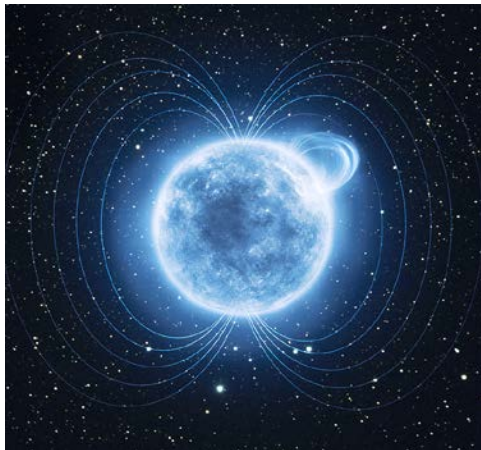


# Key physics questions (1)

How **baryonic matter** behaves in the core of Neutron Stars? At densities several times that in the atomic nuclei?

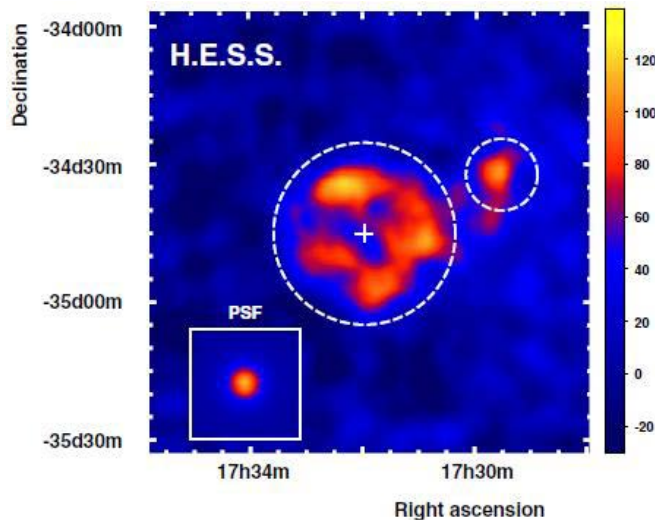


How **light and plasma** behave in the highest magnetic fields observed in the Universe? Observed in accreting pulsars and magnetars?





What is **Dark Matter** and do we have indirect evidence of its nature in astrophysics?



How **are particles (cosmic rays!) accelerated to their very high energies** and how they diffuse in the interstellar medium?

**Observations of Galaxies,  
Neutron Stars, SNR, Black  
Holes...**



# High energy astrophysics heritage



Balloon &  
Rocket  
Experiments

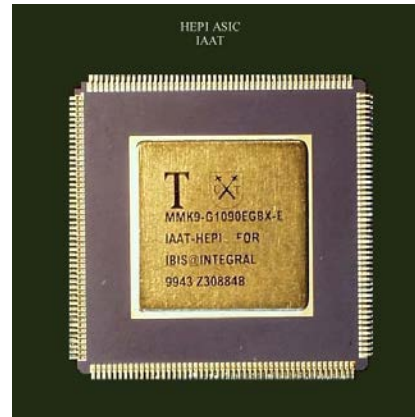
From the  
70S

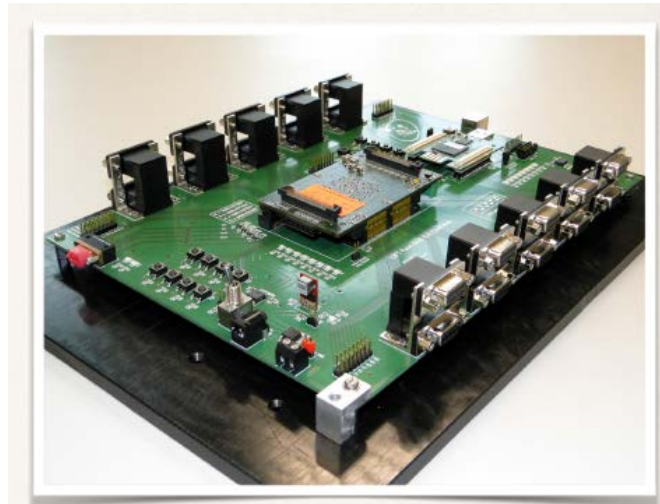


XMM-Newton



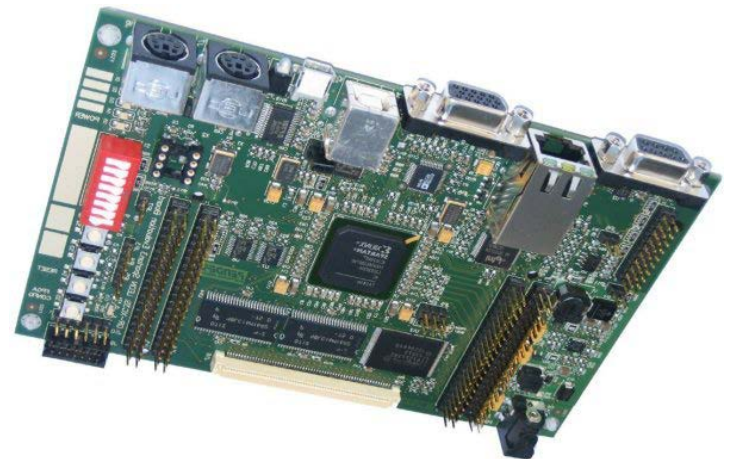
INTEGRAL





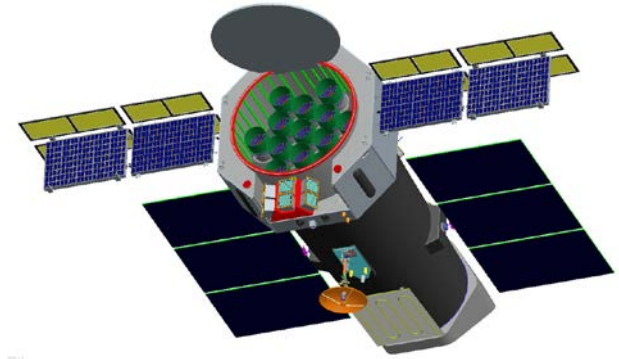
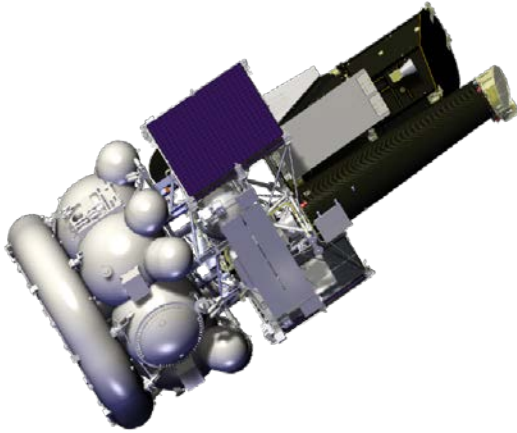
Prototype of boards for the digital electronics of **a new space instrument called LAD**

Prototype board for the Data Handling Unit is the major controlling element of the **Wide Field monitor instrument**.

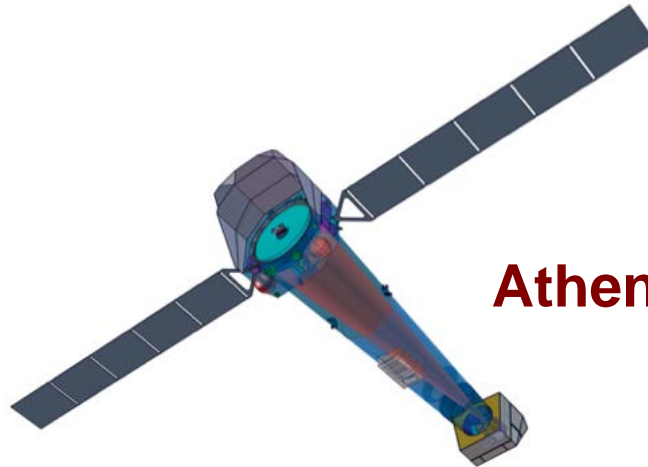




## Spectrum X-Gamma (2018)



**eXTP (2024)**



**Athena (2028)**

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## Ground Based TeV Astrophysics



*Analysis &  
Interpretation:  
Binaries, PWNe, MW*



PT-DESY  
Projekträger DESY



GEFÖRDERT VOM

Bundesministerium  
für Bildung  
und Forschung

*Experimental: Mirror testing  
and control, Alignement  
System, Electronics, Tools for  
Data Analysis*

## Space-Based UHE Astrophysics



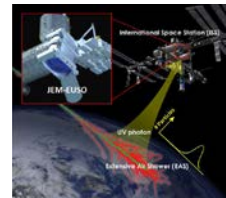
HELMHOLTZ  
GEMEINSCHAFT

*Analysis &  
Interpretation, (E2E  
simulations)*



DLR  
Projekträger im DLR

*Experimental: Onboard  
electronics, Mission  
Developments, Simulations*

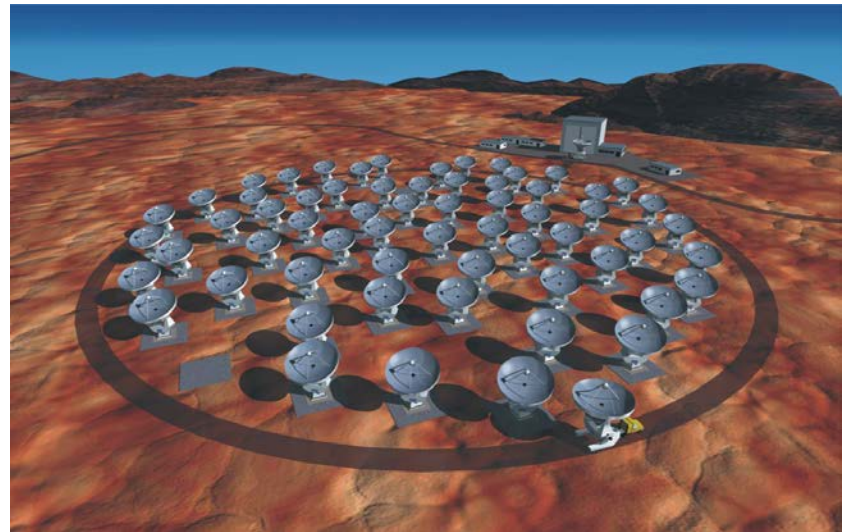




## H.E.S.S. I & II



Cherenkov  
Telescope Array  
(CTA)  
*FlashCam (Fully  
digital camera)*





- X-ray instruments for which **IAAT has done calibration activities:**
    - **BeppoSAX** (ME, HPGSPC, but good command of data analysis for all instruments)
    - **XMM-Newton** (EPIC CCDs, including PN)
    - **INTEGRAL** (SPI, IBIS)
    - ...
  - X-ray instruments for which **IAAT has used data:**
    - **BeppoSAX, XMM-Newton, INTEGRAL**
    - **RXTE, Chandra, Swift-XRT, Swift BAT, ASCA, Ginga, COMPTON-GRO, EXOSAT, ...**
    - **HESS, in general multi-wavelength experience.**
    - **HXMT(?)**
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The main people involved in the collaboration with HXMT:



Victor Doroshenko  
Assistant to the Chair



Lorenzo Ducci, WM



Prof. Rüdiger Staubert



Long Ji, WM



Santina Piraino, WM



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- Her X-1

- all available HXMT data of Her X-1, and some simultaneous Integral/NuSTAR observations. **We focus on the CRSF which is an import probe to the energy-channel relation.**
  - The line observed by HMXT is consistent with INTEGRAL SPI's results, but systematically ( $\sim 1\text{keV}$ ) higher than NuSTAR.
  - Analysis of Her X-1 continuum for checking the Response Matrix
  - Future plans?
-



- **Crab**

- Analysis of the BeppoSAX NFIs instrument data
  - according to what suggested by GM (Pulse spectrum of a given phase).
  - Indexes of the power law will be obtained in the MECS (1-10keV), HPGSPC (3-34 keV) and PDS (18-200 keV) energy ranges
  - NuStar is more difficult, lower priority, unless considered urgent.
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- **Swift J0243.6+6124**

- **Spectral and timing analysis** on this source with **NuStar and HXMT**.
  - 1) improving orbital parameters; 2) tracking the pulse profile changes over the outburst; 3) the evolution of the breaking frequency during the outburst.
  - Spectral changes related to the luminosity, associated with strong changes in the pulse profile: **change of regime?**
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- **Background tests**

- Using pulsars (too early to be discussed)
- Ready to do tests that considered necessary by IHEP.



- **Persistent Accreting Pulsars**

- Her X-1
- Vela X-1 (see talk by Rüdiger Staubert)
- X Per
- GX 301-2

- **Transient Accreting Pulsars**

- GRO J1008-57
- Swift J0243.6+6121
- GX 304-1
- ...

- **Low Mass X-ray Binaries**

- GS 1826-238
  - 4U 1636-53
  - 4U 1735-44
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# How to finance our joint research

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EBERHARD KARLS  
UNIVERSITÄT  
TÜBINGEN



## CSC-Tübingen PhD Scholarship Program

**Next round for 2019! Be ready in Autumn 2018**

China Scholarship Council (CSC) and the University of Tübingen have established a PhD Program which supports Chinese nationals inside and outside of China wishing to carry out all or part of their PhD study in Tübingen

Full Time Fellowships **PHD in Tübingen up to 48 months**

Part Time Fellowships **Part of the PHD in Tübingen 6-24 months**

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**Deutsche Forschungsgemeinschaft**

**Joint Sino-German Research Projects**



Projektträger im DLR

**Specific Project funds, Verbundforschungs**

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# Thank you.

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