

# Heidelberg

## Max-Planck-Institut für Kernphysik

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### 0 Allgemeines

Die astrophysikalische Forschung am Institut besteht aus experimenteller Gamma-Astronomie (Bereich von W. Hofmann), sowie zugehörigen Arbeiten in den Gruppen Hochenergie-Astrophysik, Theoretische Astrophysik und Infrarot-Astrophysik. Hinzu kommen Forschung auf dem Gebiet der Sonnenneutrinos, die in der neugegründeten Abteilung für Teilchen- und Astroteilchenphysik von M. Lindner eingegliedert wurde, Hoch-Energie Neutrino-Astronomie mit IceCube, die von der Emmy-Nöther-Nachwuchsgruppe (E. Resconi) betrieben wird und in-situ Untersuchungen von interplanetarem und interstellarem Staub in unserem inneren Sonnensystem, die von der Staubgruppe (R. Srama) durchgeführt werden.

Wichtigstes Gemeinschaftsprojekt ist das *High Energy Stereoscopic System (H.E.S.S.)* in der bodengebundenen Gamma-Astronomie bei sehr hohen Energien (W. Hofmann). Die erste Phase von H.E.S.S. (H.E.S.S. Phase I) in Namibia ist seit Ende 2003 voll in Betrieb. Sie umfasst vier optische 12m-Teleskope. Die Erweiterung des Teleskopsystems durch Hinzufügen eines sehr viel größeren 28m-Teleskops (H.E.S.S. Phase II), die den Einsatzbereich bis hin zu niedrigeren Energien (etwa 30 GeV) erweitern soll, befindet sich in der Bauphase. Darüberhinaus spielt das Institut eine führende Rolle bei der Planung des zukünftigen "Cherenkov Telescope Array" (CTA).

Die Hochenergie-Astrophysik Gruppe des Instituts (F. Aharonian) ist auf der einen Seite am Betrieb des H.E.S.S.-Experiments, der Datenanalyse und der Interpretation der Beobachtungen (zusammen mit der H.E.S.S.-Gruppe) beteiligt. Auf der anderen Seite stehen theoretische Untersuchungen der Strahlungsprozesse in einem breitbandigen Spektralbereich. Die theoretischen Untersuchungen zielen teilweise auf grundlegende physikalische Prozessen, wie die Beschleunigung von Teilchen der Kosmischen Strahlung. Ein anderer Teil ist auf die physikalischen Eigenschaften von spezifischen Arten von Quellen wie Supernova-Überreste, Plerions, Micro-Quasare, AGNs, Galaxien und Galaxien-Haufen gerichtet und wird auch für die quantitative physikalische Auswertung von H.E.S.S. Daten verwendet.

Die Theoretische Astrophysik (J.Kirk) beschäftigt sich allgemein mit nichtthermischen Prozessen im Universum, unter anderem mit der Physik von Pulsaren und Supernova Überresten und deren Bedeutung für die beobachtende TeV-Astronomie.

In der Infrarot-Astrophysik (R. Tuffs) wurde Beobachtungen mit dem *Spitzer* Weltraumte-

leskop der NASA durchgeführt, komplementär zu theoretischen Untersuchungen des Einflusses der Staubkomponente auf das Emissionsspektrum und die Strahlungsabsorption von Galaxien vom UV-Bereich bis zum submm-Gebiet. In Vorbereitung zukünftiger Missionen beteiligt sich die Gruppe an einer Machbarkeitsstudie für die vorgeschlagene japanische-europäische Infrarot Weltraumteleskop SPICA (“Space Infrared Telescope for Cosmology and Astrophysics”).

Die Emmy-Nöther-Nachwuchsgruppe (E. Resconi) beteiligt sich am Projekt “IceCube” durch Datenanalysen, phänomenologische Studien und Interpretationen von Daten, die durch das Vorgängerteleskop “AMANDA” gewonnen worden sind. Die Daten von ICECUBE werden zur Zeit aus 79 von insgesamt 86 geplanten “Phototube Strings” gewonnen. Ein zusätzliches Projekt, “IceCube Deep Core”, das den Nachweis von Niedrig-Energie Neutrinos ermöglichen wird, wurde im Haus entwickelt und in Betrieb genommen.

Nach dem Abschluss des erfolgreichen Sonnenneutrino-Experiments *Gallium Neutrino Observatory (GNO)* beteiligt sich das Institut am Sonnenneutrino-Experiment *Borexino* im Untergrundlabor in Gran Sasso (Italien). Messungen des  ${}^7\text{B}$  Neutrinoflusses mit Borexino wurden seit 2007 durchgeführt. Inzwischen konnte die Genauigkeit des  ${}^7\text{B}$ -Flusses auf etwa 5% verbessert werden. Dadurch wurde eine Präzision von  $< 1\%$  des *pp*-Neutrinoflusses erreicht. Darüberhinaus konnte eine Obergrenze für die Luminosität des CNO-Neutrinoflusses von 3,3% der gesamten Neutrino-Luminosität abgeleitet werden. Alle Resultate stimmen mit theoretische Erwartungen für das Standard-Solarmodell sowie für Neutrino-Oszillationen überein. Gegenwärtige Arbeiten haben den Schwerpunkt *pep*- und *pp*-Neutrinos aus dem *pp*-Fusionszyklus als auch Neutrinos aus dem CNO-Zyklus direkt nachzuweisen.

Die Staubgruppe (R. Srama) ist maßgeblich mit einem eigenen Instrument an der Weltraum-Mission *CASSINI* beteiligt. In Vorbereitung auf zukünftige Missionen auf dem Gebiet der Staubastronomie wird ein Staubteleskop zur in-situ Messung von interplanetarem und interstellarem Staub in unserem inneren Sonnensystem entwickelt. Das Staubteleskop besteht aus einem Trajektorien-Sensor und einem Flugzeitmassenspektrometer, die simultane Messungen der Zusammensetzung, Geschwindigkeitsvektor, Primärladung und Masse der Staubteilchen erlaubt. Das Staubteleskop findet Anwendung bei den Missionsvorschlägen “DuneXpress” und “SARIM” im Rahmen des “Cosmic Vision” Programmes der ESA.

In der Labor-Astrophysik (W. Krätschmer) wurden die Untersuchungen über Kettenmoleküle des Kohlenstoffs und der Oxide dieser Spezies fortgesetzt. Die ausserordentlich starken Infrarot Absorptionen des Oxides sollten astronomisch beobachtbar sein.

Ins Einzelne gehende Berichte über die längerfristigen Forschungsarbeiten am Institut enthält der 2-jährige Tätigkeitsbericht 2007/2008 des Instituts, der sowohl in verkürzter Form (“Compendium”) wie auch in voller Länge auf der Webseite des Institutes unter der Adresse: <http://www.mpi-hd.mpg.de> abgelegt ist. Er ist auch in Papierformat erhältlich über PD Dr. Sparn, Tel. (06221)516-295, e-mail: [gunter.sparn@mpi-hd.mpg.de](mailto:gunter.sparn@mpi-hd.mpg.de).

Das Institut ist maßgeblich beteiligt an der *International Max-Planck Research School for Astronomy and Cosmic Physics (IMPRS) at the University of Heidelberg*. Mehrere Doktoranden am Institut sind Mitglieder der IMPRS.

Ebenso ist das Institut an dem Sonderforschungsbereich 439 (“Galaxien im jungen Universum”) der DFG beteiligt.

## 1 Personal

### *Direktoren:*

Prof. W. Hofmann., Prof. M. Lindner, Prof. H.J. Völk (emeritiert)

### *Auswärtige Wissenschaftliche Mitglied:*

Prof. F.A. Aharonian

### *Arbeitsgruppenleiter:*

Prof. W. Hampel, Prof. J.G. Kirk, Prof. W. Krätschmer, Dr. E. Dr. E. Resconi, Dr. W. Rodejohann, Dr. S. Schönert, Dr. R. Srama, Dr. R.J. Tuffs

### *Wissenschaftliche Mitarbeiter:*

Dr. A. Clapson, Dr. C. Coluard, Dr. U. Beckmann, PD. Dr. K. Bernlöhr, Dr. E. de Ona Wilhelmi, Dr. W. Domainko, Dr. A. Förster, Prof. E. Grün (Emeritiert Mai 2009), Dr. A. Gross, Dr. G. Hermann, Dr. P. Hofverberg, Dr. S. Hoppe, Dr. J. Kiko, Dr. S. Kempf, Dr. K. Kosack, Dr. A. Merle, G. Moragas-Klostermeyer, Dr. J. Oehm, Dr. M. Panter, Dr. F. Postberg, Dr. M. Raue, Dr. F. Rieger, Dr. C. Roucelle, Dr. H. Simgen, Dr. O. Tibolla, Dr. C. van Eldik, Dr. F. Volpe, Dr. G. Zuzel

### *Doktoranden:*

J. Agarwal, I. Arka, M. Barnabe-Heider, D. Budjas, R. Buehler, C. Colnard, C. Deil, K. Egberts, M. Grootes, M. Heisel, Hsiang-Wen Hsu, E. Kafexhiu, E. Lefa, W. Maneschg, A. Mocher, G. Natale (IMPRS), D. Nekrassov, S. Odrowski, U. Reichl, O. Schulz, Y. Sestayo, E. Simmat, V. Sterken, P. Strub, O. Zacharopoulou

### *Diplomanden:*

J. Hahn, R. Gast, E. Simmat, M. Voge, M. Wolf

### *Technisches Personal:*

J. Baumgart, A. Berneiser, E. Borger, S. Bugiel, E. Burkert, R. Crespo, H. Fuchs, F. Garrecht, S. Koudari, G. Linkert, W. Müller, U. Schwan, G. Weese

### *Wissenschaftliche Gäste:*

Dr. M. Barkov (Russland), Prof. E.G. Berezhko (Russland), Dr. S. Bogovalov (Russland), Dr. V. Bosch-Ramon (Spanien), Dr. S. Casanova (Italien), Dr. R. Crocker (Australien), Dr. J. Fischera (Canada), Dr. J. Gracia (Deutschland), Dr. D. Jones (Australien), Prof. S. Kelner (Russland), Dr. D. Khangulyan (Russland), Dr. A. Koldoba (Russland), Dr. U. Lisenfeld (Spanien), Dr. E. de Ona Wilhelmi (Spanien), Dr. Z. Osmanov (Georgia), Dr. B. Reville (Irland), Dr. A. Smolnikov (Russland), Dr. D. Strelnikov (Russland), Dr. A. Takanobu (Japan), Dr. A. Taylor (UK), Dr. G. Ustyugova (Russland), Dr. V. Zirakashvili (Russland)

### *Berufungen*

Dr. Stefan Schönert: Ruf auf den Lehrstuhl für experimentelle Astroteilchenphysik an der Technischen Universität München

## 2 Lehrveranstaltungen, Ausbildung von Studenten:

*Universität Heidelberg, Sommersemester 2009:*

Prof. J. Kirk (mit Dr. S. Wagner/LSW): Particle Astrophysics (Lecture)

Dr. W. Rodejohann: The Standard Model of Particle Physics II: Theory (Lecture)

*Universität Heidelberg, Wintersemester 2009:*

PD Dr. K. Bernlöhr: Hochenergieastrophysik

Prof. J. Kirk (mit Dr. F. Rieger und Dr. S. Wagner/LSW): Sources of high-energy radiation (Seminar).

Dr. W. Rodejohann: Aktuelle Themen der Astroteilchenphysik: Theorie und Experiment (Seminar)

*Sonstige Universitäten:*

Prof. F. Aharonian: Radiation Processes in High Energy Astrophysics (Vorlesung, Trinity College Dublin)

Dr. S. Kempf: Himmelsmechanik (Vorlesung, Universität Braunschweig)

Dr. R. Srama: Astronomiemissionen und Raumfahrtanwendungen/Staubsensorik (Vorlesung, Universität Stuttgart)

*International Schools:*

F. Aharonian: Nagoya University Winter School, Japan, Feb 2009 (1 lecture); DPG Physics School 2009 on "Astroparticle Physics" Bad Honnef, Sep. 2009 (1 lecture); 27th Jerusalem Winter School in Theoretical Physics, Jerusalem, Israel, Dec. 2009 (1 lecture).

K. Bernloehr: 4th Heidelberg Astronomy Summer School, August 2009 (1 lecture)

G. Hermann: Summer School in multi-Wavelength Astronomy, Paris, Juli 2009 (1 lecture).

E. Resconi: Schule für Astroteilchenphysik Universität Erlangen-Nürnberg Okt. 2009 (1 lecture)

## 3 Tagungen, Vorträge

### 3.1 Beteiligung an der Veranstaltung von Tagungen:

2nd Heidelberg Workshop: High-Energy Gamma-rays and Neutrinos from Extra-Galactic Sources, Heidelberg, 13-16. Januar. 2009 (F. Aharonian, E. Resconi)

European Planetary Science Congress, Münster, 14.-18. September 2009 (R. Srama)

LAUNCH 09: Neutrinos and Beyond: Conference on Neutrinos and Dark Matter in Particle, Astroparticle and Nuclear Physics, Heidelberg, 9-12 November 2009 (M. Lindner, W. Rodejohann, S. Schönert).

TeV Particle Astrophysics 2010, Paris 19-23 Juli 2009 (session coordinator neutrino astrophysics E. Resconi)

### 3.2 Öffentliche Vorträge und Veranstaltungen:

Hofmann, W.: Physik am Samstagmorgen, Heidelberg, Germany

## 4 Mitarbeit in Gremien:

Aharonian, F: Co-Director LEA (European Associated Laboratory on High Energy Astrophysics); ESA representative on the Science working group of the JAXA-NASA X-ray mission ASTRO-H; Member of the International Review Board of the Helmholtz Association on “Astroparticle Physics”; Member of the European ASTRONET Infrastructure Roadmap Panel A: “High Energy Astrophysics, Astroparticle Physics Gravitational Waves”; Member of the Editorial Board of “International Journal of Modern Physics: D”; Member H.E.S.S., CTA Collaboration Boards; Member KM3NeT Consortium Board; Member of the Scientific Committee of the International Center for Relativistic Astrophysics (Italy).

Grün, E: European Space Science Committee; Co-I of Rosetta COSIMA; Co-I of Bepi-Colombo MMO Mercury Dust Counter; Co-I of Cassini Cosmic Dust Analyzer, CDA; Co-I of Ulysses Dust Detector

Hermann, G.: Co-coordinator Cherenkov Telescope Array

Hofmann, W: Chair of CPT Section of the Max-Planck Society; Member of the “Gutachterausschuss Erdbundene Astrophysik und Astroteilchenphysik des BMBF”; Member of Scientific/Technical Council of Forschungszentrum Karlsruhe; Member of the “ApPEC” (Astroparticle Physics European Coordination) Peer Review Committee; Member of the “Kommittee für Astroteilchenphysik (KAT)”; Member H.E.S.S. Collaboration Board; Spokesperson of the H.E.S.S. Collaboration

Kempf, S: Co-I of Cassini Cosmic Dust Analyzer; Co-I of Ulysses Dust Detector

Krätschmer, W.: Gutachter der Deutschen Forschungsgemeinschaft (DFG),

Resconi, E.: Data Analysis coordinator, ICECUBE

Schönert, S: Spokesperson, GERDA Collaboration; Member of the BOREXINO ISAPP and DoubleChooz boards; Member of the “ApPEC” (Astroparticle Physics European Coordination) Peer Review Committee;

Srama, R: Arbeitsgemeinschaft Extraterrestrische Forschung; Europlanet Coordinator; PI of Cassini Cosmic Dust Analyzer; Co-I of Bepi Colombo Dust Detector, Coordinator European Geoscience Union.

Tuffs, R.J.: Member of the collaboration board for the european instrument SAFARI for the JAXA/ESA SPICA mission.

Völk, H.J.: Associate Member (IAU) to the IUPAP Commission on Cosmic Rays (C4); Member H.E.S.S. Collaboration Board; Member Steering Committee, European Associated Laboratory (LEA) on High Energy Gamma-ray Astronomy

## 5 Veröffentlichungen

### 5.1 In Zeitschriften mit Referee-System:

Abbasi, R. et al. (IceCube Collaboration): Extending the Search for Neutrino Point Sources with IceCube above the Horizon. *PhRvL* **103** (2009), 221102

Abbasi, R. et al. (Ice Cube Collaboration): First Neutrino Point-Source Results from the 22 String Icecube Detector. *ApJ* **701** (2009), L47–L51

Abbasi, R. et al. (IceCube Collaboration): The IceCube Data Acquisition System: Signal Capture, Digitization, and Timestamping. *Nucl.Instrum.Meth.* **A601** (2009), 294–316

- Abbasi, R. et al. (IceCube Collaboration): Search for High-Energy Muon Neutrinos from the “Naked-Eye” GRB 080319B with the IceCube Neutrino Telescope [Erratum: 2010 ApJ vol. 708, pg. 911]. ApJ **701** (2009), 1721–1731
- Abbasi, R. et al. (IceCube Collaboration): Limits on a Muon Flux from Neutralino Annihilations in the Sun with the IceCube 22-String Detector. PhRvL **102** (2009), 201302
- Abbasi, R. et al. (IceCube Collaboration): Determination of the atmospheric neutrino flux and searches for new physics with AMANDA-II. PhRvD **79** (2009), 102005
- Abbasi, R. et al. (IceCube Collaboration): Search for point sources of high energy neutrinos with final data from AMANDA-II. PhRvD **79** (2009), 062001
- Acciari, V.A et al. (VERITAS Collaboration; VLBA 43 GHz M87 Monitoring Team; HESS Collaboration; MAGIC Collaboration): Radio Imaging of the Very-High-Energy  $\gamma$ -Ray Emission Region in the Central Engine of a Radio Galaxy. Science **325** (2009), 444–447
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- Acerro, F. et al. (Hess Collaboration): Probing the ATIC peak in the cosmic-ray electron spectrum with HESS A&A **508** (2009), 561–564
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- Aharonian, F. et al. (Hess Collaboration): Very high energy  $\gamma$ -ray observations of the binary PSR B1259-63/SS2883 around the 2007 Periastron. A&A **507** (2009), 389–396
- Aharonian, F. et al. (Hess Collaboration): Spectrum and variability of the Galactic center VHE  $\gamma$ -ray source HESS J1745-290. A&A **503** (2009), 817–825
- Aharonian, F. et al. (Hess Collaboration): Simultaneous multiwavelength observations of the second exceptional  $\gamma$ -ray flare of PKS 2155-304 in July 2006. A&A **502** (2009), 749–770
- Aharonian, F. et al. (Hess Collaboration): Constraints on the multi-TeV particle population in the Coma galaxy cluster with HESS observations. A&A **502** (2009), 437–443
- Aharonian, F. et al. (Hess Collaboration): Detection of very high energy radiation from HESS J1908+063 confirms the Milagro unidentified source MGRO J1908+06. A&A **499** (2009), 723–728
- Aharonian, F. et al. ((Hess Collaboration & Fermi-LAT Collaboration): Simultaneous Observations of PKS 2155-304 with HESS, Fermi, RXTE, and Atom: Spectral Energy Distributions and Variability in a Low State. ApJ **696** (2009), L150–L155
- Aharonian, F. et al. (Hess Collaboration): HESS upper limit on the very high energy gamma-ray emission from the globular cluster 47 Tucanae. A&A **499** (2009), 273–277
- Aharonian, F. et al. (Hess Collaboration): Discovery of Very High Energy  $\gamma$ -Ray Emission from Centaurus A with H.E.S.S. ApJ **695** (2009), L40–L44
- Aharonian, F. et al. (Hess Collaboration): Discovery of Gamma-Ray Emission From the Shell-Type Supernova Remnant RCW 86 With HESS. ApJ **692** (2009), 1500–1505
- Aharonian, F. et al. (Hess Collaboration): HESS observations of  $\gamma$ -ray bursts in 2003-2007. A&A **495** (2009), 505–512
- Aharonian, F. et al. (Hess Collaboration): Very high energy gamma-ray observations of the galaxy clusters Abell 496 and Abell 85 with HESS. A&A **495** (2009), 27–35

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