Arbeitsgruppe Physik und Abrüstung (AGA)

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Zur Abrüstung, der Verhinderung der Verbreitung von Massenvernichtungsmitteln und der Beurteilung neuer Waffentechnologien sind naturwissenschaftliche Untersuchungen unverzichtbar. Auch bei der Verifikation von Rüstungskontrollabkommen werden neue Techniken und Verfahren benötigt und eingesetzt. Schwerpunkte in diesem Jahr bilden Themen wie die nukleare Abrüstung, Verifikation bzw. die Detektion von Nuklearanlagen und Materialien, Raketenabwehr und Zerstörung von Nuklearsprengköpfen, neue militärrelevante Technologien wie Drohnen.

Die Fachsitzung wird von der DPG gemeinsam mit dem Forschungsverbund Naturwissenschaft, Abrüstung und internationale Sicherheit FONAS durchgeführt. Die 1998 gegründete Arbeitsgruppe Physik und Abrüstung ist für die Organisation verantwortlich. Die Sitzung soll international vorrangige Themen behandeln, Hintergrundwissen vermitteln und Ergebnisse neuerer Forschung darstellen.

Übersicht der Hauptvorträge und Fachsitzungen

(Hörsaal S Aula)

Max-von-Laue Lecture

PV IX	Mi	20:00–21:00	H 1	**Max-von-Laue-Lecture: From the "Vergangenheit der Physik" to the "Future of Physics": Monolingualism and the Transformation of a Science** — •Michael D. Gordin

Hauptvorträge

AGA 2.1	Do	9:00– 9:50	S Aula	**Things Changed - Or Did They? An Update on Recent Rocket Developments in North Korea** — •Markus Schiller
AGA 2.2	Do	9:50–10:40	S Aula	**Ein nüchterner Blick auf die Raketensupermacht Nordkorea** — •Robert Schmucker
AGA 2.3	Do	11:00–12:00	S Aula	**Is the United States Trying to Aim Its National Missile Defense at China?** — •Theodore A. Postol
AGA 2.4	Do	12:00–13:00	S Aula	**The Aegis Missile Defense System and Future Nuclear Arms Reductions** — •George N. Lewis
AGA 3.1	Do	14:00–15:00	S Aula	**Technical Challenges to Nuclear Disarmament Verification - A UK perspective** — •David Chambers
AGA 3.2	Do	15:00–16:00	S Aula	**Why the JCPoA is a solid deal - interfaces between technology and diplomacy in the nuclear negotiations between the E3/EU+3 and Iran** — •Darius Rahimi-Larijani, Rafael Heinisch
AGA 4.1	Do	16:15–17:15	S Aula	**Scientific methods to analyse the CTBT International Monitoring System data with emphasis on the area or radionuclide analysis** — •Martin Kalinowski

Fachsitzungen

AGA 1.1–1.3	Mi	16:45–18:15	S Aula	**Nuclear Energy and Security (Joint Session AKE-AGA)**
AGA 2.1–2.4	Do	9:00–13:00	S Aula	**Missiles and Missile Defense - Rockets in North Korea, US and China**
AGA 3.1–3.2	Do	14:00–16:00	S Aula	**Political and Technical Challenges to Disarmament and Nuclear Diplomacy**
AGA 4.1–4.3	Do	16:15–18:15	S Aula	**The Nuclear Test Ban Treaty and its Verification**

AGA 5.1–5.1	Fr	9:00– 9:30	S Aula	**New Military Technologies**
AGA 6.1–6.2	Fr	9:30–10:30	S Aula	**Fissile Materials**
AGA 7.1–7.3	Fr	10:30–12:00	S Aula	**Seismic and Acoustic Verification**

Mitgliederversammlung Arbeitsgruppe Physik und Abrüstung

Donnerstag 18:30–19:30 S Aula

- Bericht der Sprecher
- Wahl der Sprecher
- künftige Aktivitäten
- Verschiedenes

AGA 1: Nuclear Energy and Security (Joint Session AKE-AGA)

Zeit: Mittwoch 16:45–18:15 Raum: S Aula

Hauptvortrag AGA 1.1 Mi 16:45 S Aula
Nuclear Power and Nuclear Safety Post Fukushima — •Christoph Pistner and Matthias Englert — Öko-Institut e.V., Rheinstraße 95, 64295 Darmstadt

On March 11, 2011, the second "major accident" in a civilian nuclear power plant after Chernobyl took place in Fukushima Dai-ichi. A major earthquake and resulting tsunami lead to a core melt in three reactors and the following relocation of more than 100.000 residents. But still, worldwide there are 450 nuclear reactors operational today. Safety checks like the EU-Stresstest took place after Fukushima and possibilities for optimization have been identified basically everywhere. Fukushima emphasized the importance of taking natural events more thoroughly into account and led to the implementation of additional safety equipment. But still, events from internal and external causes continue to happen frequently. In addition to these "conventional" safety problems, also other threats gain in importance. Besides the danger of terrorist attacks on nuclear facilities, also the deterioration of the institutional environment due to a military or economic crisis has to be taken into account. Thus, nuclear power remains to be a technology with the inherent potential for catastrophic accidents.

Hauptvortrag AGA 1.2 Mi 17:15 S Aula
Safeguards and Non-Proliferation experience from an IAEA perspective — •Tariq Rauf — formerly IAEA, Head Verification and Security Policy, Vienna

The International Atomic Energy Agency (IAEA) has been implementing nuclear safeguards for more than half a century covering peaceful nuclear activities. IAEA safeguards are implemented in States pursuant to legal authority from the IAEA Statute and bilateral, regional and international nuclear non-proliferation treaties and agreements; and are set of technical measures that allow the IAEA to independently verify a State's legal commitment not to divert nuclear material from peaceful nuclear activities to nuclear weapons or other nuclear explosive devices. In 1991, the IAEA safeguards system suffered a massive shock when it was discovered that Iraq was running an heretofore undetected parallel undeclared nuclear (weapon acquisition) programme. As a result, the IAEA safeguards system was strengthened based on a combination of expanded information and technical measures through the Additional Protocol (to safeguards agreements). Further challenges to the IAEA safeguards system came during 1992 through 2015, from the DPRK, Iran, Libya, South Korea and Syria. This presentation describes the structure and technical elements of safeguards, including implementation in high-priority cases.

Hauptvortrag AGA 1.3 Mi 17:45 S Aula
Civil Nuclear Power - The Cyber Security Perspective — •Guido Gluschke — Institute for Security and Safety at the Brandenburg University of Applied Sciences, Potsdam, Germany

The talk will discuss the situation at nuclear facilities in the digital age. It will elaborate on the cyber-related challenges of the safety and security domains. Furthermore, the talk will introduce the concept of design basis threat which represents the IAEA methodology for risk treatment in terms of physical protection and will have a look how cyber fits into this model. Finally, some international initiatives on cyber security will be presented.

AGA 2: Missiles and Missile Defense - Rockets in North Korea, US and China

Zeit: Donnerstag 9:00–13:00 Raum: S Aula

Hauptvortrag AGA 2.1 Do 9:00 S Aula
Things Changed - Or Did They? An Update on Recent Rocket Developments in North Korea — •Markus Schiller — ST Analytics GmbH, München, Germany

As of December 2016, North Korea launched the unprecedented number of 25 large missiles and rockets in 2016 alone. Among these were missile types that were known before but never launched (the Musudan), or that were completely unknown before (the Scud ER). Combined with media events that showed static engine tests, warhead heat shield tests, or mock-ups of nuclear warheads, the threat situation emanating from North Korea seems to have changed significantly in 2016. This presentation gives a brief overview about the recent events and offers to shed some light on their actual meaning.

This presentation is planned in combination with a follow-up presentation by Robert H. Schmucker that will deal with the technical details.

Hauptvortrag AGA 2.2 Do 9:50 S Aula
Ein nüchterner Blick auf die Raketensupermacht Nordkorea — •Robert Schmucker — Schmucker Technologie, Klenzestraße 14, D-80469 München

Mit der Machtübernahme in Nordkorea durch Kim Jong-uns haben sich Raketenerprobungen massiv verstärkt. Neben den bis dahin bereits bekannten Raketentypen, die praktisch alle auf Scud-Technologie basieren, wurden neue Raketenwaffen erkennbar, die man entweder auf Paraden zeigte oder in Versuchsserien erprobte.

Neben den Modellen zweier Interkontinentalraketen sind wegen einer Reihe von Abschüssen zwei mobile, landgestützte Systeme (Kurzstreckenrakete ER-Scud, Mittelstreckenrakete Musudan) und eine U-Boot-Rakete von Interesse:

Die beiden ersten Typen lassen sich problemlos hinsichtlich Technik und Herkunft analysieren; die bisherigen Darstellungen der U-Boot-Rakete zeigen die wahre Lage Nordkoreas auf diesem Gebiet klar auf. Zusammen mit diesen Erkenntnissen und der Analyse der anderen Geräte kann man damit die wirklichen Fähigkeiten Nordkoreas beschreiben und so die zukünftig zu erwartenden Entwicklungen abschätzen.

20 min. break

Hauptvortrag AGA 2.3 Do 11:00 S Aula
Is the United States Trying to Aim Its National Missile Defense at China? — •Theodore A. Postol — Massachusetts Institute of Technology

The United States has been pressing South Korea to accept the THAAD ballistic missile defense, supposedly to address the ballistic missile threat to South Korea from North Korea. However, it will be shown that the THAAD missile defense is very susceptible to simple countermeasures that are well within the technical capacity of North Korea to implement and that THAAD will not be capable of providing useful levels of defense for South Korea. On the other hand, THAAD has a very powerful radar known as the AN/TPY-2 which is much more powerful than what is needed for such a defense. The radar is also designed and equipped with communications systems to send tracking data directly to the US National Missile Defense. As such, these capabilities could be used to cue the new US Long-Range Discrimination Radar (LRDR) currently under construction in Clear, Alaska, to locations where Chinese ICBMs will rise over the radar horizon of the curved earth. Such cuing information would substantially increase the time available for the LRDR to observe Chinese ICBM-payloads in an effort to differentiate between Chinese warheads and decoys. The cuing information could also be used by the US National Missile Defense to launch interceptors more quickly, theoretically increasing its capacity to use shoot-look-shoot tactics against Chinese warheads. This expansion of US National Missile Defense sensors by the US government and the lack of real defensive capacity to defend South Korea from the North create the appearance that the real US objective is to aim the US National Missile Defense against China rather than to defend South Korea.These technical facts help to explain why the US attempt to place a THAAD radar in South Korea has caused concern in China. They are also much like circumstances in Europe, where the US-NATO European Phased Adaptive Approach (EPAA) continues to move forward in spite of the Iran Nuclear Deal, which has eliminated the alleged nuclear threat to Europe from Iran.

Hauptvortrag AGA 2.4 Do 12:00 S Aula

The Aegis Missile Defense System and Future Nuclear Arms Reductions — •George N. Lewis — Judith Reppy Institute for Peace and Conflict Studies Cornell University

Planned future development of the U.S. Navy's Aegis missile defense system, in particular the deployment of large numbers of the next generation SM-3 Block IIA interceptors, could severely and adversely affect future efforts to reduce nuclear arsenals. Current Aegis Block I interceptors, while in principle capable of intercepting ICBMS, cannot cover a large enough area to serve as the basis for a defense of U.S. territory. However, under current plans, the number of advanced capability Aegis missile defense ships is about to begin to increase rapidly. Similarly, the number of much more capable Block IIA interceptors, scheduled for first deployment in 2018, will similarly begin a rapid increase in the early 2020s. These Block IIA interceptors could cover the entire continental United States from a few off-shore locations. By the mid- to late-2030s there could be 400-600 or more Block IIAs (or successors) deployed, mostly on about 80 BMD ships. At that point, the number of US strategic-capable interceptors, including ground-based systems, could be comparable to the number of survivable Russian ICBM/SLBM warheads and larger than the number of Chinese warheads. This talk considers the potential effects of these deployments on future nuclear reductions, and possible steps to mitigate those effects

AGA 3: Political and Technical Challenges to Disarmament and Nuclear Diplomacy

Zeit: Donnerstag 14:00–16:00 Raum: S Aula

Hauptvortrag AGA 3.1 Do 14:00 S Aula

Technical Challenges to Nuclear Disarmament Verification - A UK perspective — •David Chambers — Foreign and Commonwealth Office, London

This presentation will outline the key issues which bring particular technical challenges to the verification of nuclear disarmament. Since 1998 the UK has been looking to address the technical challenges of verification in nuclear weapons facilities. The presentation will use the UK*s experiences to demonstrate potential ways to approach these challenges, including identifying where new and innovative technological solutions will be required. This will include lessons learned through the UKs bilateral projects with both the USA and Norway, and show the equal importance of roles for those that possess nuclear weapons and those that do not. Finally the most recent initiatives will be considered, the US led International Partnership on Disarmament Verification and the four nation Quad initiative. These multinational approaches present new opportunities and demonstrate how future initiatives can make effective and efficient use of resources to address the challenges remaining.

Hauptvortrag AGA 3.2 Do 15:00 S Aula

Why the JCPoA is a solid deal - interfaces between technology and diplomacy in the nuclear negotiations between the E3/EU+3 and Iran — •Darius Rahimi-Larijani and Rafael Heinisch — Foreign Office, Berlin

The JCPoA agreed in Vienna on 14 July 2015 was a rare success of diplomacy in the Middle East built on the Nuclear Non-Proliferation Treaty. Endorsed by UN Security Council Resolution 2231 (2015), the JCPoA ensures that Iran's nuclear programme serves exclusively peaceful purposes. Tight restrictions on Iran's uranium enrichment programme and the modernisation of the Arak research reactor limit Iran's capability to produce weapons-grade material in any possible break-out scenario. Any attempt to do so would be immediately detected by the IAEA which exercises a hitherto unprecedented level of transparency measures. In focusing on the interfaces between technology and diplomacy, this presentation makes the case for the JCPoA as a deal which has made the region and beyond safer and more secure.

AGA 4: The Nuclear Test Ban Treaty and its Verification

Zeit: Donnerstag 16:15–18:15 Raum: S Aula

Hauptvortrag AGA 4.1 Do 16:15 S Aula

Scientific methods to analyse the CTBT International Monitoring System data with emphasis on the area or radionuclide analysis — •Martin Kalinowski — International Data Centre Division, CTBTO

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) bans nuclear explosions by everyone and everywhere in the atmosphere, underwater and underground. In preparation for entry into force of the Treaty, the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) has been tasked to establish the International Monitoring System (IMS) to monitor the planet for signs of nuclear explosions. The IMS consists of 321 globally distributed monitoring stations that continuously provide in near real-time measurements of seismic, infrasound, hydroacoustic and radioactivity sensors. The five announced nuclear tests of the Democratic People*s Republic of Korea have all been detected and this demonstrates the effectiveness of the monitoring system. The CTBTO maintains close cooperation with the scientific community to constantly refine its methods and ensure that the verification regime operates at the cutting edge of scientific knowledge. This presentation describes the science and technology process and uses the area of radionuclide analysis as an example how processing and interpretation of IMS data is improved by research and methodology developments. Global efforts are undertaken to understand the radioxenon background in the atmosphere that results from civil sources, to characterize the observations at IMS noble gas systems and to screen them for possible indications of signals that may be caused by a nuclear explosion so as to optimize the detectability of nuclear tests.

Slides in English, presentation in German.

AGA 4.2 Do 17:15 S Aula

Stand und geplante Neuerungen der ATTA (Atom Trap Trace Analysis) an der Universität Hamburg — •Friderike Göring[1], Markus Kohler[1], Carsten Sieveke[1], Pablo Woelk[1], Simon Hebel[1], Peter Sahling[1], Gerald Kirchner[1], Christoph Becker[2] und Klaus Sengstock[2] — [1]Carl Friedrich von Weizsäcker Zentrum für Naturwissenschaften und Friedensforschung, Universität Hamburg, Beim Schlump 83, 20144 Hamburg — [2]Institut für Laser-Pyhsik, Universität Hamburg, 22761 Hamburg

Das Kryptonisotop Kr-85 gilt als gut geeigneter atmosphärischer Tracer für die Entdeckung geheimer nuklearer Wiederaufbereitungsaktivitäten. Für einen möglichen Einsatz der Kr-85-Analyse im Rahmen von Maßnahmen zur Verhinderung der Proliferation nuklearer Waffen ist ein hoher Probendurchsatz und damit kurze Analysezeiten auch bei geringen Probengrößen erforderlich.

Die Eignung von Atom Trap Trace Analysis (ATTA) als Nachweismethode für geringe Kr-85-Konzentrationen wurde bereits in mehreren Experimenten verschiedener Forschungseinrichtungen bestätigt. Im ATTA-Aufbau der Universität Hamburg wird metastabiles Krypton auf rein optische Weise erzeugt, wodurch der Probendurchsatz gegenüber bisher existierenden ATTA-Anlagen vervielfacht werden soll.

AGA 4.3 Do 17:45 S Aula

CTBT Verification - Atmospheric Release of Xenon from Civil Nuclear Power Plants — •Matthias Englert and Christoph Pistner — Öko-Institut e.V., Rheinstr. 95, 64295 Darmstadt

Efficient verification is a vital component of the comprehensive test ban treaty (CTBT) that supports global efforts for nonproliferation and disarmament. For verification purposes the comprehensive test ban treaty organization CTBTO will be using the global monitoring system with its technical components to detect nuclear detonations, after entry into force. Acoustic and seismic verification technologies are complemented by detecting radionuclides such as the fission prod-

uct xenon. Discrimination between civil sources of xenon in nuclear power production from xenon released during a nuclear explosion can be accomplished comparing the differing isotopic vectors of the noble gas. We calculated different isotopic vectors of xenon produced in nuclear power plants with neutronic simulations under typical operating conditions in the plant and compared them with older models. Different production mechanisms in nuclear power reactors will be discussed including a sensitivity analysis of the isotopic vector to fuel element geometry, burnup, fuel composition, reactor type, power level and others. Finally we will present estimates about the release of xenon to the atmosphere from a power plant under different operation conditions such as shut-down, start of operation and accidental releases.

AGA 5: New Military Technologies

Zeit: Freitag 9:00–9:30 Raum: S Aula

AGA 5.1 Fr 9:00 S Aula

The Proliferation of Drone Technology — •Christian Alwardt, Götz Neuneck, and Johanna Polle — IFSH Universität Hamburg

Both, in the area of civilian and military application, unmanned aerial systems, so-called drones, have experienced an increasing proliferation in the last decade. The underlying drone technology is characterized by a strong dual-use nature, integrating diverse fields of technology, material and application. Thereby, a sharp classification, characterization or export control of drone technology is barely possible and thus facilitating the further distribution of the relevant key technologies. Within the last years the spread of military drones has intensively increased. Furthermore, a rising number of countries plan to acquire combat drones. However, the vast majority of today*s systems have serious limitations, revealing them unfavorable to operate in conventional and symmetric military hostilities. The additional military value of this system is subject to narrow confines. The talk analyses the status of today*s drone technology and by this means, concludes the current capabilities and scope of application of drone systems. The main focus is on the worldwide spread of military drone as well as on the tendencies in vertical and horizontal proliferation. The talk will close by sheding light on the question of arms control and in what extent its instruments could provide effective means for the non-proliferation of drone technology.

AGA 6: Fissile Materials

Zeit: Freitag 9:30–10:30 Raum: S Aula

AGA 6.1 Fr 9:30 S Aula

Long-lived Fission Products in the Spent Fuel from Accelerator-Driven Systems in a Transmutation Fuel Cycle — •Friederike Friess[1,2] and Wolfgang Liebert[1] — [1]ISR, Universität für Bodenkultur Wien (BOKU), Österreich — [2]IANUS, TU Darmstadt, Deutschland

In the light of the still unsolved problem of radioactive waste disposal, the idea of Partitioning and Transmutation (P&T) of minor actinides or all transuranic elements in fast reactors systems is proposed as a possible solution. Doing so would reduce the radiotoxicity of the spent fuel, leading proponents to the conclusion that safe containment in the final repository must be ensured only for several thousand compared to millions of years.

Based on depletion calculations for a generic Accelerator-Driven System (ADS), the build-up of different radionuclides in the spent fuel, assuming inert matrix fuel with an increased content of minor actinides, is calculated. Their concentration is compared to the concentration in conventional spent fuel. The focus lies on long-lived fission products such as Zr-93, Te-99, I-129 and Cs-135 that are of great relevance to the long-term safety evaluation of the final repository. The study shows that a P&T fuel cycle leads to an unproportional high generation of Cs-135 in the spent fuel. Results indicate that it might not be sufficient to only consider the amount of additional fission products when evaluating the impact of different fuel cycles on the spent fuel inventory.

AGA 6.2 Fr 10:00 S Aula

The PRISM Reactor as a Possible Option to Deal with the British Civilian Plutonium Stockpile — •Christopher Fichtlscherer[1] and Friederike Friess[1,2] — [1]IANUS, TU Darmstadt, Deutschland — [2]ISR, Universität für Bodenkultur Wien (Boku), Österreich

Dealing with stocks of separated weapon-usable plutonium is a big challenge for our modern society. This work focuses on the British civil plutonium stockpiles, which amount to 103.3 tons. One option is seen in irradiating the plutonium in a fast reactor under development, namely the GE PRISM reactor. The PRISM reactor is a small modular, fast reactor which has a thermal power of 840 MW and an electrical output of 311 MW. It is intended to use MOX fuel and proponents claim, that it thus would be possible to produce clean energy, while making the plutonium proliferation resistant.

A MCNP model of the reactor is built and depletion calculations with different target burnups of the fuel were conducted to check whether the burned material would fulfil the Spent-Fuel Standard. Particularly it was checked whether the spent fuel is self protecting, meaning that the dose rate does not fall below a limit of 1 Sv/h in 1 meter distance after a cooling period of 30 years. Based on the reactor model calculations the irradiation time to fulfill this limit for the spent fuel is calculated. Based on the needed target burnup, it can be verified, whether it is possible for the PRISM reactor to render the civil plutonium proliferation resistant in only 20 years as is is claimed by its proponents.

AGA 7: Seismic and Acoustic Verification

Zeit: Freitag 10:30–12:00 Raum: S Aula

AGA 7.1 Fr 10:30 S Aula

Safeguards for Final Repositories: Using Analytical Seismic Signals — •Jürgen Altmann — Experimentelle Physik III, Technische Universität Dortmund, 44221 Dortmund

To analyse the potential of seismic monitoring for detecting undeclared activities at an underground final repository for nuclear waste, seismic propagation had been modelled numerically at a salt dome with a complex underground structure. The model had included frequency-dependent attenuation but the time and space resolutions were limited; signal frequencies were below a few hundred Hz.

The results showed that the amplitude changes on transmission through media boundaries were relatively modest. Thus a homogeneous-medium model without any boundaries was used where the seismic wave field can be described by analytic formulae, and the signal frequencies are not limited. The analytical amplitudes fit very well to the numerical ones; with signal frequencies up to a few hundred Hz, in salt and other consolidated sediments the numerical amplitudes start to get lower at around 1 km, probably because they include attenuation.

It seems that the analytic treatment by a homogeneous medium can give useful results for the estimation of signal strengths at relevant

distances, important for a first estimate of the capabilities of a potential monitoring system. For more realistic results frequency-dependent attenuation needs to be included.

AGA 7.2 Fr 11:00 S Aula

Spektrale Trennung zweier Sinus-Funktionen mit geringem Frequenzunterschied — •Marc Bürger — Experimentelle Physik III, TU Dortmund, 44221 Dortmund

Der Umfassende Atomteststoppvertrag CTBT (Comprehensive Nuclear-Test Ban Treaty) ist ein internationales Abkommen über das vollständige Verbot von Kernexplosionen. Mit den Sensoren des internationalen Überwachungssystems kann der Bereich einer möglichen Kernexplosion bis in die Größenordnung 10 km aufgelöst werden. Vor-Ort-Inspektionen der CTBTO können seismische Sensoren nutzen, um durch kleinste Signale von Nachbeben den Explosionsherd genauer zu orten. Nachbeben können durch den bei einer unterirdischen Kernexplosion entstandenen Hohlraum verursacht werden. Diese Signale sind schwach und werden von zahlreichen Störquellen, wie Landfahrzeugen, Helikoptern oder Flugzeugen überlagert. Im Unterschied zu den Signalen der seismischen Beben zeichnen sich viele Störquellen durch eine Periodizität aus. Ziel ist es, die Störquellen im Spektralbereich zu charakterisieren, um die periodischen Frequenzanteile zu entfernen. Die Charakterisierung eines monofrequenten Signals ist bereits gelöst. In diesem Vortrag geht es um die Erkennung von zwei Sinus-Funktionen mit geringem Frequenzunterschied, wie sie zum Beispiel durch Flugzeuge mit zwei Propellern verursacht werden. Zu erkennen ist dieser Fall an der Breite eines Peaks im Amplitudenspektrum, dessen Form unterschiedlich sein kann. Durch nicht-lineare Anpassung an diese Form sollen die Parameter (Amplitude, Frequenz, Phase) der beiden Sinus-Funktionen gewonnen werden.

AGA 7.3 Fr 11:30 S Aula

Ortung seismischer Signale — •Sonja Lemke — Experimentelle Physik III, TU Dortmund, 44221 Dortmund

Die Ortung seismischer Quellen hat vielfältige Anwendungsmöglichkeiten in der Abrüstung, unter anderem in der Verifikation des Umfassenden Atomteststoppvertrags (CTBT), der Überwachung von atomaren Endlagern sowie in der Überwachung von Waffenstillstandsverträgen. Die seismische Detektion besitzt oft Vorteile: Im Fall eines Endlagers können die Geophone außerhalb des verschlossenen Endlagers und oberflächennah angebracht werden; bei der Überprüfung von Waffenstillstands- und Abrüstungsverträgen kann die aufgezeichnete Information auf das notwendige Minimum beschränkt werden, um die militärischen Geheimnisse der beteiligten Parteien zu wahren.

In diesem Vortrag werden unterschiedliche Möglichkeiten vorgestellt, um Zeitunterschiede zwischen an verschiedenen Positionen angebrachte Geophonen zu detektieren: Kreuzkorrelation und das Verhältnis von Kurz- zu Langzeitmittelwert der Signalamplitude. Die Rückrechnung auf eine Signalquelle kann mit einer direkten geometrischen Methode erfolgen, wofür vier Sensororte nötig sind. Mehr Sensoren gehen z.B. in das Maximum-Likelihood-Verfahren ein, das auch toleranter gegenüber Fehlern ist. Die implementierten Algorithmen werden vorgestellt und deren Genauigkeit mit Hilfe von echten und theoretischen Signalen analysiert. Außerdem werden die besonderen Schwierigkeiten seismischer Signale behandelt, die sich unter anderem durch unbekannte Wellengeschwindigkeiten und Reflektionen ergeben.