Intersectional Symposium Cultural Heritage in the Light of Physical Methods (SYCH)

lead by the Atomic Physics Division (A)

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History of arts and archeology are supposed to reveal the generation of cultural objects being produced in the past. However, in many cases this process is not known, oftentimes no documents on the history of the objects do exist at all. Physical methods such as X-ray fluorescence spectroscopy, mass spectrometry, and neutron autoradiography do provide valuable insights into the materials and the way of producing the art objects, information being forgotten over time. Even more, these methods make it possible to reconstruct the generation of an art object. In particular, looking underneath the surface of a painting reveals its production step by step hundreds of years after its original creation.

Overview of Invited Talks and Sessions

(lecture room HSZ 02)

Invited Talks

SYCH 1.1	Thu	14:00–14:30	HSZ 02	**Radiocarbon dating of cultural objects: Limit** — •Hans-Arno Synal
SYCH 1.2	Thu	14:30–15:00	HSZ 02	**From Lascaux to Rembrandt. Insights into invisible traces of paintings and drawings from physical methods** — •Ina Reiche
SYCH 1.3	Thu	15:00–15:30	HSZ 02	**IPANEMA, A European research platform for the study of ancient and historical materials** — •Loïc Bertrand
SYCH 1.4	Thu	15:30–16:00	HSZ 02	**3D X-ray view of treasures** — •Birgit Kanngiesser, Ioanna Mantouvalou, Wolfgang Malzer
SYCH 2.1	Thu	16:30–17:00	HSZ 02	**Looking below the surface of paintings by help of neutrons** — •Claudia Laurenze-Landsberg, Carl Otto Fischer
SYCH 2.2	Thu	17:00–17:30	HSZ 02	**X-ray fluorescence analysis using synchrotron radiation excitation** — •Martin Radtke, Günter Buzanich, Uwe Reinholz, Heinrich Riesemeier
SYCH 2.3	Thu	17:30–18:00	HSZ 02	**Metabolic tools to study wine body** — •Oliver Fiehn, Kirsten Skogerson, Gert Wohlgemuth
SYCH 2.4	Thu	18:00–18:30	HSZ 02	**Identification of Ancient Plant Textiles** — •Bodil Holst, Bridget Murphy

Sessions

SYCH 1.1–1.4	Thu	14:00–16:00	HSZ 02	**Cultural Heritage in the Light of Physical Methods I**
SYCH 2.1–2.4	Thu	16:30–18:30	HSZ 02	**Cultural Heritage in the Light of Physical Methods II**

SYCH 1: Cultural Heritage in the Light of Physical Methods I

Time: Thursday 14:00–16:00 Location: HSZ 02

Invited Talk SYCH 1.1 Thu 14:00 HSZ 02
Radiocarbon dating of cultural objects: Limit — •Hans-Arno Synal — ETH Zurich, Zurich, Switzerland

Reliable age information is in many cases essential to classify cultural object into their historical context. Here, radiocarbon dating plays an outstanding role contributing most valuable dates of the organic materials from which these objects are made. Today, radiocarbon is a well establish dating technique but it is still following the fundamental principles as they were discovered by William Libby in the middle of the last century. However, modern technologies to measure radiocarbon concentrations in organic materials have substantially improved and opened up new and unique opportunities. In particular, the latest improvements in accelerator mass spectrometry have push forward radiocarbon methodology. In this contribution latest technical and instrumental developments are summarized and their implications to retrieve time information of cultural objects are highlighted. Specific examples are given to demonstrate present day possibilities and limitations of modern radiocarbon dating.

Invited Talk SYCH 1.2 Thu 14:30 HSZ 02
From Lascaux to Rembrandt. Insights into invisible traces of paintings and drawings from physical methods — •Ina Reiche — Laboratoire du C2RMF - UMR 171 CNRS, Palais du Louvre, 14 quai F. Mitterrand, 75001 Paris, France

Beyond art historical studies, analyses of works of art using chemical and physical methods can bring to light invaluable information on the objects and their history, which in turn reflects know-how and life style of past societies. Art and archaeological objects are very diverse in terms of the materials they are made of. They are heterogenous composite materials and altered over time. Consequently, problems related to the fabrication, the raw material origin, the dating or the conservation of art objects can be very varied. Characteristic markers that can reveal such information are minor or trace elements, special isotope ratios or specific phases present in small amounts. Therefore, analytical strategies using complementary physical and chemical methods are developed as a function of the object material, the raised questions and the possibility to sample for the analyses or not. Non-invasive approaches are generally privileged because of the precious nature of the objects of our cultural heritage. Laboratory equipments but also large scale facilities such as synchrotron sources are used. Taking as examples the study of Lascaux cave paintings, pigments from Ancient Egypt and India as well as drawings made by Rembrandt, van Eyck or Dürer, the physico-chemical approach in the field is illustrated. Special method developments are emphasized and data interpretations within the archaeological or art-historical context discussed.

Invited Talk SYCH 1.3 Thu 15:00 HSZ 02
IPANEMA, A European research platform for the study of ancient and historical materials — •Loïc Bertrand — IPANEMA UPS-3352 CNRS, synchrotron SOLEIL, Gif-sur-Yvette cedex - FRANCE

The IPANEMA European research platform for ancient and historical materials (archaeology, artwork conservation, palaeontology and past environments) is under construction at the SOLEIL synchrotron (Saint-Aubin, France, 25 km SW Paris). The new building adjoining the SOLEIL synchrotron is due to open in 2012 to European and international users. The activities of the facility are centred on two fields: increased support to researchers and methodological research.

Since the opening of SOLEIL, IPANEMA supported more than 20 projects including works on pigment degradation in paintings, identification of rock art painting techniques and alteration, composition of musical instrument varnishes, provenancing of mediaeval archaeological ferrous artefacts. Once the platform is fully operational, user support will primarily take place within medium-term research projects adapted to hosted scientists.

IPANEMA research will focus on 2D/3D imaging and statistical image analysis of ancient materials, including through the setting-up of PUMA, a new hard X-ray beamline currently in its conceptual design phase.

Access to SOLEIL / IPANEMA for European user groups working on ancient materials is supported through FP7 CHARISMA (EC).

Invited Talk SYCH 1.4 Thu 15:30 HSZ 02
3D X-ray view of treasures — •Birgit Kanngiesser, Ioanna Mantouvalou, and Wolfgang Malzer — Technische Universität Berlin, Berlin, Deutschland

X-radiation is the light for going into the depth. It has the appropriate energy to penetrate and explore matter on a macroscopic as well as on an atomic scale. In atoms deep core holes can be created in order to investigate the fundamental reactions of the many electron system to this *deep* perturbation. Among these fundamental reactions is the emission of fluorescence light, which may be utilised as a highly sensitive *fingerprint* of the acting atom and its chemical environment. On the macroscopic scale matter can be illuminated and investigated within depths ranging up to the cm regime. X-ray fluorescence spectroscopy is a research and technology tool which benefits from both the radiation properties and instrument developments. Besides being a spectroscopy tool it is also a highly successful non-destructive analytical method for the determination of elemental composition in a large variety of fields of application.

The newest methodological development in X-ray fluorescence spectroscopy is its expansion into the depth with a confocal set-up for X-rays using X-ray optics. If the sample is scanned systematically in the lateral dimension as well as into the depth a 3D Micro X-ray Fluorescence Spectroscopy can be performed. Just from the beginning one main field of application of the method was art and cultural heritage. On the basis of examples the wide range of application of this 3D X-ray view of treasures is outlined.

SYCH 2: Cultural Heritage in the Light of Physical Methods II

Time: Thursday 16:30–18:30 Location: HSZ 02

Invited Talk SYCH 2.1 Thu 16:30 HSZ 02
Looking below the surface of paintings by help of neutrons — •Claudia Laurenze-Landsberg[1] and Carl Otto Fischer[2] — [1]Gemäldegalerie, Staatliche Museen zu Berlin — [2]Helmholtz-Zentrum für Materialien und Energie

The research using the Neutron-Autoradiography method is in collaboration with the Helmholtzzentrum für Materialien und Energie, Berlin and the Gemäldegalerie of the Staatliche Museen Berlin. The Gemäldegalerie Berlin is the only institute world wide, which systematically employs the method of Neutron-Activation-Autoradiography to analyse paintings. Today we have investigated about 70 mainly 17th century works.

The paintings to be investigated are scanned by means of neutron activation. The isotopes arising during this process have specific half-lives and emit gamma and beta energies. For a period of up to six weeks after activation x-ray films are placed on the painting exposing them to the radiation. Hereby, paint layers, which vary in colour, can be separated on different films and supply valuable additional data to x-radiographs.

Deeper paint layers are made visible. In this way, it is possible to gain insight into the work process and the artistic approach of the painter. A hidden composition might reveal another artist's influence on the painter, which might be important for the dating. The elucidation of the brushstroke can be read as the handwriting of the artist responsible for the painting. Examples for these various findings by using non-destructive autoradiography will be shown.

Invited Talk SYCH 2.2 Thu 17:00 HSZ 02
X-ray fluorescence analysis using synchrotron radiation excitation — •Martin Radtke, Günter Buzanich, Uwe Reinholz, and Heinrich Riesemeier — BAM Bundesanstalt für Materialforschung und -prüfung

Archaeology and Archaeometry are two emergent fields in materials science with an increasing demand of access to synchrotron radiation (SR) based techniques such as X-ray imaging, X-ray Diffraction, X-ray fluorescence and IR spectroscopy. These methods allow the characterization of specific features or fingerprints of the materials that are often comprised of trace element compositions or the presence of particular minor phases that can be for instance, used as a marker of the provenance of a material or a distinct fabrication technique.

In this contribution especially the use of SR for the analysis of ancient gold objects using X-ray fluorescence (SRXRF) is presented. After an introduction to the properties of SR the results for measurements at the Sky Disc of Nebra, the Berlin Gold hat and the Hiddensee treasure are discussed.

All examples of this presentation have been measured with the SR-XRF setup at the BAMline at BESSY II. A superconducting wavelength shifter with a maximum field of 7 Tesla is the X-ray source. The useable energy ranges from 5 up to 80 keV. Thus nearly all elements can be detected by measurement of their K-shell flourescence. With compound refractive lenses a beam diameter of 1 micron can be achieved.

Invited Talk SYCH 2.3 Thu 17:30 HSZ 02

Metabolic tools to study wine body — •Oliver Fiehn, Kirsten Skogerson, and Gert Wohlgemuth — UC Davis, Genome Center, U.S.A.

Are wine tasting panels really objective? Can physical measurements mimic human reception of wines? Our senses perceive a wide variety of compounds, from volatiles (odor) to polyphenolics (tannins), acids, and numerous other metabolites. Quantitative analysis of 'all compounds', called metabolomics, might therefore replace or complement human wine tasters. However, no single technical platform can analyze all metabolites present in a biological sample. When several platforms are combined, 500-3,000 metabolites can be assessed per biological study using chromatography (GC, LC) coupled to mass spectrometry (TOF, ion trap, QTOF, FT-ICR MS) in combination with standardized spectral libraries and databases.

An exemplary study is presented for predicting wine body of 20 white wines, using the results of categorization of mouthfeel viscosity from trained wine panelists. By applying metabolomic results and multivariate statistics, mouthfeel viscosity was predicted at 80% confidence. Interestingly, the human sensation of wine body is not perceived by compounds that might otherwise be accounted for 'high viscosity' (such as sugar alcohols, glycerol or lactate) but amino acids. We also confirmed that no single biomarker could accurately predict wine body, whereas a panel of few compounds was found to be pretty close to the average scores of the wine tasting panel.

Invited Talk SYCH 2.4 Thu 18:00 HSZ 02

Identification of Ancient Plant Textiles — •Bodil Holst[1] and Bridget Murphy[2] — [1]University of Bergen, Department of Physics and Technology, Bergen, Norway — [2]University of Kiel, Institute of Experimental and Applied Physics, Kiel, Germany

Archaeological textiles are made of natural fibers, which can be divided into two subgroups according to their origin. The two subgroups are animal fibers (wool, hair and silk) and plant fibers (flax, nettle, hemp etc.). Based on archaeological finds, it is believed that the first textiles were made of wild plant fibres. Up till now it has been the general assumption that the development of textile production was closely linked to the development of agricultural society through the use of cultivated textile plants (primarily flax and hemp). In this paper we challenge this assumption: Using new analysis methods which we have recently developed, we present conclusive evidence for high quality textile production based on the collection of wild plants in a Bronze Age agricultural society. Specifically, we show that the 2800 year old Bronze Age textile found in Voldtofte, Denmark is made of nettle.

Our investigation suggests that plant textile production in Bronze Age central Europe was based not only on agriculture, but also on the targeted exploitation of wild plants. It highlights the importance of nettle as a textile plant and suggests that a re-examination of many existing plant textile finds with new analysis techniques is called for.