Western Michigan University
Department of Physics Colloquia
2003-2004

Speaker: Paul Pancella
Western Michigan University
September 29, 2003

“First Observation of the Forbidden Reaction dd → απ0”

Abstract: Against long odds, the final nuclear physics experiment performed at the Indiana University Cyclotron Facility was a success. A non-zero cross section for the dd → απ0 reaction was measured at two beam energies just above threshold. This process, in which two nuclei of heavy hydrogen (deuterons) fuse to form one helium nucleus (alpha particle) with the creation of a neutral pion, conserves mass-energy, momentum, electric charge, and total number of protons and neutrons. However, it is “forbidden” because it violates isospin conservation and charge symmetry, two related symmetries of the strong nuclear force which governs this reaction. This observation is a direct measurement of the degree of charge symmetry breaking (CSB) in the strong force, and thus provides insight into the fundamental nature of the force which holds nuclei together.

The potential theoretical impact of this measurement extends from nuclear and particle physics through cosmology. CSB is closely related to the mass difference between up and down quarks, and the mass difference between protons and neutrons, with all the attending consequences for the universe. This talk, however, will concentrate on the experimental challenges of measuring a cross section in the tens of pico-barns range at an accelerator that has been declared obsolete.

Speaker: John Tanis
Western Michigan University
October 13, 2003

“Young-Type Interferences in Electron Emission from H2”

Abstract: When an electron is ejected coherently from the identical atomic centers of a molecule, quantum mechanical interference can occur. This phenomenon is analogous to Young’s two-slit experiment, in which the atomic centers act as a pair of “slits”. While such interference was predicted nearly four decades ago, it was only recently that the first experimental evidence for this effect was observed in fast ion-atom collisions. The
confirmation of the existence of these effects represents an important milestone in understanding phenomena that are peculiar to molecules composed of identical atomic centers. Recent experimental results will be presented as well as the theoretical framework for understanding the observed interference effects.

**Speaker: J. Thomas Dickinson**
Washington State University
October 20, 2003
“The Interaction of Ultraviolet and Ultrafast Lasers with Materials”

**Abstract:** Lasers in science and in technology are ubiquitous. The use of UV photons in technology has proven to be very attractive for modifying and etching surfaces of transparent materials such as silica and single crystal dielectrics as well as organic polymers. Excimer lasers are dependable sources of nanosecond pulses of light ranging from 157 nm to 308 nm. Also of considerable promise is the use of femtosecond lasers which are found to readily interact with wide bandgap materials through non-linear (multiphoton) absorption. We review the fundamentals of how both of these types of lasers interact with materials and give examples of the physical and chemical consequences of these interactions.

**Speaker: A. I. Kolesnikov**
Argonne National Laboratory
November 10, 2003
“Neutron Scattering Study of the High Pressure Metal Hydrides”

**Abstract:** Hydrides of the group VI-VIII transition metals were synthesized under high hydrogen pressures (up to 90 kbar) and studied by neutron diffraction (ND) and inelastic neutron scattering (INS). The produced monohydrides of Cr, Mn, Fe, Co, Ni, Mo, Rh and Pd have close-packed metal sublattices with hcp, fcc or dhcp structure, in which hydrogen atoms occupy octahedral interstitial positions. The energy of the main optical H peak exhibits a strong monotonous increase as a function of the hydrogen-metal distance, R, in the hydrides of both 3d- and 4d-metals. The increase in R by itself should imply weakening interatomic interactions, and the observed opposite effect thus indicates a significant increase in the hydrogen-metal interaction with decreasing atomic number of the host metal, which outweighs the influence of the accompanying R decrease in the hydrides.

The spectra for fcc NiH and PdH appear strongly anisotropic at energy transfers above the fundamental band of optical hydrogen vibrations, while those for fcc PdD do not show a significant directional dependence at energies of the second optical D band.
A giant tunnelling effect was observed for H dissolved in α-Mn. ND study has shown that H atoms in α-Mn occupy the position in a double-well potential with very short distance between the minima of 2d=0.68 Å. INS investigation of α-MnH0.07 and α-MnD0.05 at T=1.7-200 K over a wide range of energy and momentum transfers were carried out. Together with the high energy bands of the optical vibrations, pronounced peaks at 6.3 and 1.6 meV were observed in the spectra of the samples loaded with H and D, respectively. Temperature, momentum-transfer and isotope dependence of the spectra clearly demonstrated the tunnelling origin of these peaks. The H tunnelling peak in the INS spectrum of α-MnH0.073 shows an anomalously high energy of 6.3 meV which is a gigantic 30 times larger than for H in other metals. Deuterium tunnelling in metals has not been detected previously by neutron spectroscopy.

Speaker: David Hoffman
University of Illinois at Chicago
November 17, 2003
“‘Hot and Heavy' - The Latest Results from RHIC”

Abstract: The Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory has accelerated beams of Au, d and p at energies up to 100 GeV/u. Collisions of Au+Au, d+Au and p+p have been measured in four experiments; BRAHMS, PHENIX, PHOBOS and STAR. The goal of these experiments is to create, identify and study a new phase of matter called the quark-gluon-plasma. Recent data from d+Au and p+p point to new and exciting signatures which suggest a hot and dense phase of hadronic matter has been created. Results on the global features of heavy ion collisions as well as more detailed studies of particle production, spectra and correlations will be presented and discussed, both from the perspective of the PHOBOS experiment as well as in the broader context of the RHIC program as a whole.