TNET: The EURONS European Theory Network
Second Workshop ECT* Trento, 7-11 January 2008
Abstracts in order of presentation

Ron Johnson (Surrey): Transfer Reactions with Deuterons
In the late 1960's I developed, with P J R Soper and J D Harvey, a method of calculating (d,p) and (p,d) cross sections which (i) went well beyond the then current DWBA method and included effects due to excitation of the deuteron break-up continuum in a non-perturbative way; (ii) could be easily implemented by a small modification of a DWBA code; (iii) did not involve the concept of a deuteron optical potential with its associated uncertainties; (iv) involved fewer parameters to be determined independently than is needed for a typical DWBA calculation. The method is usually presented as an adiabatic, high energy theory. I will discuss the theoretical challenges involved in extending the range of application of the method to low energies.

Pierre Descouvement (Brussels): Challenges for three-body scattering problems
I plan to describe general issues in 3-body scattering for non-resonant processes (where the phase shifts are needed) and for resonant processes (where approximate methods are available). I will briefly tackle non-microscopic as well as microscopic cluster theories, and show the difficulties associated with a proper treatment of 3-body asymptotics. This will be illustrated by some projects going on at the moment: the 5H and 5He(T=3/2) systems, and the 3-alpha process.

Winfried Leidemann (Trento): Study of reactions with the Lorentz integral transform (LIT) method
The LIT approach allows one to carry out *ab initio* calculations of reactions taking into account correctly the many-body continuum. The large range of applications is discussed for nuclei in the mass range from A=2-7.

Mahir Hussein (MPI Dresden): Absorption-Fluctuation Theorem for Nuclear Reactions
We discuss the connection between absorption, averages and fluctuations in nuclear reactions. The fluctuations in the entrance channel result in the compound nucleus, Hauser-Feshbach, cross section, the fluctuations in the intermediate channels, result in modifications of multistep reaction cross sections exemplified by the possible excitation of Brink-Axel phonons in, e.g., multi-phonon giant resonances. The fluctuations in the final channel result in hybrid cross sections that can be used to describe incomplete fusion reactions. We discuss the latter in detail and comment on the validity of the assumptions used in the development of hybrid reaction theories (Trojan horse, Surrogate method). We also discuss the theory of multistep reactions with regards to intermediate state fluctuations and the energy dependence and non-locality of the intermediate channels optical potentials.

Raquel Crespo (IST, Lisboa): Faddeev multiple scattering calculations for proton elastic and break-up scattering from halo nuclei
Full Faddeev-type calculations are performed for 11Be elastic and break-up on proton target at intermediate incident energies. The convergence of the multiple scattering expansions is investigated. For elastic scattering the results are calculated with a Glauber type calculation. For break-up, the results are compared with those of other frameworks like Distorted Wave Impulse Approximation. Both Glauber and DWIA approaches are based on incomplete and truncated multiple scattering expansions. Preliminary results for the one neutron knockout reaction of p-14Be using Faddeev and Glauber are reported.

Antonio Sa Fonseca (Lisboa): Three-body approach to direct nuclear reactions
Exact three-body equations are used to study direct nuclear reactions involving light bound systems such as deuterons or halo nuclei, where excitation to the continuum plays a important role in the reaction mechanism. We compare results with the standard theoretical approach based on the continuum discretized coupled channel (CDCC) method. Results show that the standard method fails to describe p-11Be break-up into p+n+10Be, while it leads to correct results for the break-up of

deuterons on 12C. Application to other reactions is shown. Derivation of DWBA from the exact three-body formalism is addressed.

Joaquin Gomez Camacho (Sevilla): Algebraic approach to the scattering with internal degrees of freedom
Algebraic methods to describe bound and unbound quantum states will be presented. The one-dimensional atom-molecule scattering problem will be solved using algebraic methods.

Jan Vaagen (Bergen): Lessons from Helsinki
There will be a discussion of future plans, proposals and developments subsequent to the September 2007 Joint EURISOL-EURONS Helsinki Town meeting and the status of the proposed EU Network (NRA) and Joint Research (JRA) initiatives under the FP7 banner.

Antonio Moro (Sevilla): Extracting spectroscopic information from transfer reactions involving weakly bound nuclei
In this talk, I will address the problem of the extraction of spectroscopic information from the analysis of reactions involving loosely bound nuclei. I will discuss the case of transfer to bound states as well as the case of transfer reactions populating continuum states. The first one will be illustrated with the 10Be(d,p)11Be and 11Be(p,d)10Be reactions, while in the latter I will consider the 9Li(d,p)10Li case. Several approaches will be compared and discussed.

Pierre Capel (Brussels): Analysis of 8B break-up experiments with a Dynamical Eikonal Approximation
Using the Dynamical Eikonal Approximation [D. Baye et al. Phys. Rev. Lett. 95, 082502 (2005)], we analyse different 8B break-up experiments that have been used as indirect technique to infer 7Be(p,gamma)8B astrophysical S factor. In particular, we analyse the influence of the projectile-target interaction on several break-up observables. We observe that nuclear interaction can be neglected if data are selected at sufficiently forward angles. However, the influence of the E2 term of the Coulomb potential never seems to be negligible. The accuracy of the extraction of the astrophysical S factor at stellar energies from break-up experiments therefore seems difficult to evaluate.

Marek Ploszajczak (GANIL): Many-body calculations for weakly-bound and unbound states
The recent progress in a shell model description of weakly bound and unbound many-body states will be presented. In addition to introducing the Shell Model for open quantum systems, I will concentrate on the discussion of threshold anomalies, spectroscopic factors, radial overlap functions, etc.

Jimmy Rotureau (Oak Ridge): Density Matrix Renormalization Group Approach for many body open quantum systems
We have applied the DMRG method in the context of the Gamow Shell Model (GSM). In this model, which describes the configuration mixing in open quantum many-body system, the completeness relation is resolved in the Berggren ensemble consisting of bound states, resonant states (Gamow states) and complex energy continuum states. The eigenvalue problem is inherently non-hermitian and given by complex-symmetric matrix with complex eigenvalues. Inclusion of resonances and associated continuum states leads to an explosive growth of the size of the multiconfigurational space and the standard diagonalization methods cannot be applied. To deal with this difficulty, we have solved the GSM problem using the DMRG technique in the J-scheme. I will show results we have obtained for the description of weakly bound or unbound states in He isotopes.

Sofia Quaglioni (LLNL): Extending the *ab initio* no-core shell model to the continuum via the resonating-group method.
One of the greatest challenges for nuclear physics today is the development of a quantitative, microscopic theory of low-energy reactions on light nuclei. We are building such a theory by augmenting the ab initio no-core shell model to include clustering and resonant and non-resonant continuum. For this purpose, we follow an approach in the spirit of the resonating group method. I will present our recent results on nucleon-4He scattering.

Gaute Hagen (Oak Ridge): Coupled-Cluster Approach to Nuclear Structure
The nuclear many-body problem is a challenging undertaking. Coupled-Cluster theory is a microscopic theory recently revived in the nuclear structure community. It represents an ideal compromise between accuracy on the one hand, and computational cost on the other. Further, it is a size extensive theory; this is an essential property when extending the ab-initio program into the medium mass regime of the nuclear chart. Recent developments of Coupled-Cluster theory with two- and three-body Hamiltonians, and its application to medium mass nuclei are discussed. Further, the first ab-initio calculations of lifetimes and decay widths of a whole isotopic chain starting from nucleon degrees of freedom and realistic nucleon-nucleon forces are presented. It is argued that Coupled-Cluster theory is an ideal tool in the study of properties of weakly bound and unbound nuclei beyond the lightest, and the role of three-nucleon forces in medium mass nuclei.

Markus Stauf (Manchester): Coupled cluster method with a hardcore potential for finite nuclei
Comparisons are made between the hardcore-potential formulation of the Bochum group and a new symmetric formulation. The calculations are made for the alpha particle.

Paul Stevenson (Surrey): Time-Dependent Hartree-Fock for structure and reactions
The most recent implementations of the Time-Dependent Hartree-Fock (TDHF) allow the simulation of dynamical processes in nuclei using effective interactions of the Skyrme type fitted mostly to ground state properties. We present some results using TDHF for resonances and collisions including arbitrary deformation, and discuss strengths and shortcomings of the approach, and the perspectives for improvement.

Arnau Rios Huguet (MSU): A time-dependent Green's functions approach to nuclear reactions

Hermann Wolter (Munich): The nuclear symmetry energy at low density
I will discuss information on the low-density symmetry energy from analysis of low energy heavy ion reactions.

Marcella Grasso (Orsay): Evolution of proton states in neutron-rich Ca and Ar isotopes
We analyze the evolution with increasing isospin asymmetry of the proton single-particle states 2s1/2 and 1d3/2 in Ca and Ar isotopes. It is shown that this evolution is sensitive to the neutron shell structure, the two states becoming more or less close depending on the neutron orbitals which are filled. In the regions where the states get closer some effective interactions lead to an inversion between them. We study in detail the modification of the two single-particle energies by using the equivalent potential in the Schrödinger-like Skyrme-Hartree-Fock equations. The role played by central, kinetic, spin-orbit and tensor contributions is discussed. Finally, the occurrence of a bubble structure, due to an inversion between the s1/2 and d3/2 states, is investigated in Ar isotopes.

Jeff Tostevin (Surrey): Observing correlations using reactions
Intermediate energy direct reactions, involving removal or excitation of single nucleons or pairs of nucleons, can probe nucleon structure at both the weakly- and strongly-bound Fermi surfaces of unstable nuclei. The contribution will discuss if aspects of nucleon correlations, structure calculations and/or effective interactions might be observable and clarified using such reaction mechanisms.

Haik Simon (GSI): Correlation studies in 3-body halo break-up reactions
I will present the findings for our new experimental results impinging 8He, 11Li, 14Be on a liquid hydrogen target with proton recoil detection. The results for a few unbound systems across the neutron dripline, populated with proton knock-out reactions will be discussed. If time allows I will also say a few words on the experimental reliability of our two neutron data at very low relative energy - in comparison with recent RIKEN results.

Manuela Rodriguez Gallardo (Lisboa): Standard four-body CDCC calculations

The extension of the standard CDCC method to four-body reactions is presented. The bin procedure is generalized to discretize the continuum of the three-body projectile. The method is applied to reactions induced by the Borromean nucleus 6He.

Jim Al-Khalili (Surrey): The two-potential approach to one-proton emission
An intuitive and simple way of calculating the half-lives of nuclear decays through particle emission is via the two-potential approach. The contribution will outline this method and compare results for a number of one-proton emitters with other approaches. A generalisation of the method from the 1-D case (suitable fro spherical nuclei) to 3-D to deal with deformed nuclei will be outlined.