HK 33 Kernphysik/Spektroskopie

Zeit: Dienstag 16:30–18:45 Raum: TU MA041

Gruppenbericht

HK 33.1 Di 16:30 TU MA041

Electromagnetic Strength in Single-Particle Halo Nuclei — •Stefan Typel[1] and Gerhard Baur[2] — [1]GSI Darmstadt — [2]Forschungszentrum Jülich

Nuclei close to the driplines often exhibit a pronounced nucleon+core structure that is well described by single-particle models. For low orbital angular momenta of the lowest bound valence nucleon an extended density distribution, a halo, develops resulting in a large size of the nucleus. Light exotic nuclei were studied extensively in recent years by electromagnetic excitation and a large transition strength was observed at low energies in the continuum that shows universal features when plotted in the appropriately scaled variables. The relevant matrix elements are essentially determined by the asymptotics of the wave functions and simple scaling laws apply for the transition strength [1]. Effects of the interaction in the continumm are conveniently described by the effective-range expansion since details of the interaction are not resolved at the relevant low energies. This is in the spirit of effective field theoretical approaches to halo nuclei. We introduce appropriate dimensionless scaling parameters and find explicit analytical scaling laws for several quantities like radii, probabilities, strength functions and corresponding sum rules. Electromagnetic strength functions are parametrized in terms of the separation energy of the halo nucleon, the asymptotic normalization coefficient of the bound state and the scattering length. A typical example is the neutron halo nucleus ^{11}Be [1]. The present approach provides a framework for future studies of heavier halo nuclei.

[1] S. Typel and G. Baur, Phys. Rev. Lett. 93, 142502 (2004).

Gruppenbericht

HK 33.2 Di 17:00 TU MA041

Investigation of nuclear matter distribution of the neutron-rich He isotopes by proton elastic scattering at intermediate energies — •Oleg Kiselev for the S174 collaboration — Institut für Kernchemie, Johannes Gutenberg Universität Mainz, D-55128 Mainz

The study of neutron-rich light nuclei near the drip line has attracted much attention as they exhibit an extended distribution (so-called halo) of the valence neutrons surrounding a compact core. Elastic proton scattering at intermediate energies is known as a very successful technique for exploring the nuclear matter distributions in the stable and also in the exotic nuclei. In order to supplement data taken for small-angle scattering, differential cross-sections for higher momentum transfer were measured at energies near 700 MeV/u for the neutron-rich helium isotopes ^{6,8}He using a liquid hydrogen target. The differential cross sections obtained in both experiments have been evaluated using several phenomenological parameterizations for the nuclear matter distribution within the Glauber multiple scattering theory. In addition, a model-independent analysis with the help of a Sum-Of-Gaussians method has been performed, which is a standard method for the investigation of nuclear charge distributions from electron scattering data. The results on the nuclear sizes and the radial structure of the total nuclear matter, core and halo density distributions in ^{6}He and ^{8}He will be presented. The measured differential cross sections have been also used for probing density distributions as predicted by various theoretical calculations. The comparison of the data with the latest calculations will be shown.

HK 33.3 Di 17:30 TU MA041

Struktur von ^{7}He bei niedrigen Anregungsenergien in der^{7}Li(d,^{2}He) Reaktion* — •N. Ryezayeva[1], C. Bäumer[2], A. van den Berg[3], D. Frekers[2], D. De Frenne[4], P. Haefner[2], E. Jacobs[4], H. Johansson[5], Y. Kalmykov[1], A. Negret[4], P. von Neumann-Cosel[1], L. Popescu[4], S. Rakers[2], A. Richter[1], G. Schrieder[1], A. Shevchenko[1], H. Simon[5] und H.J. Wörtche[3] — [1]Institut für Kernphysik, Technische UniversitätDarmstadt, Germany — [2]Institut für Kernphysik,Universität Münster, Germany — [3]KVI Groningen,Netherlands — [4]Laboratorium voor Kernfysica,Universiteit Gent, Belgium — [5]GSI Darmstadt, Germany

Die große räumliche Ausdehnung von Halo-Kernen kann zu einer erhebliche Modifikation der Spin-Bahnwechselwirkung führen. Jüngste Experimente geben widersprechende Aussagen über die mögliche Existenz des $p_{1/2}$-Spin-Bahnpartners des ^{7}He Grundzustands. Zur Klärung dieser Frage wurde die Reaktion ^{7}Li(d,^{2}He)^{7}He am KVI Groningen untersucht.

Bei einer Einschußenergie von 171 MeV wurden Daten im Winkelbereich Θ_{cm}= 0^0 – 11.3^0 genohmen. Die Auflösung betrug 150 keV (FWHM). Die experimentellen Ergebnisse weisen auf eine niedrigliegende Resonanz bei E_x=$(1.2^{+0.5}_{-0.4})$ MeV mit einer Breite Γ=$(1.9^{+0.8}_{-0.4})$ MeV hin. Die experimentelle Gamow-Teller Stärke für die Übergänge zu den niedrigsten Zuständen in ^{7}He stimmen mit theoretischen Vorhersagen des Quantum Monte-Carlo Modells überein.

*Gefördert durch die DFG, SFB 634, Land Nordrhein-Westfalen, EU, FOM-OWO, Fund for Scientific Research-Flandres.

HK 33.4 Di 17:45 TU MA041

Density dependent hadron field theory with nuclear matter and finite nuclei. — •Urnaa Badarch and Horst Lenske — Institut für Theoretische Physik, Universität Giessen, Germany

We have studied nuclear interactions by the coupling of nucleons to meson fields using Relativistic field theory for infinite nuclear matter and finite nuclei. In this calculations we used density dependent meson-baryon coupling constants taken from Dirac-Brueckner self-energies and loop diagrams for describing the static polarization effect. Results for infinite symmetric and anti-symmetric nuclear matter are presented. The role of the isovector interactions is investigated and compared to conventional empirical RHF models.The extension of the approach beyond the ladder approximations is discussed. Results of loop calculations are presented.The global properties of newly determined coupling constants are investigated in applications to infinite asymmetric and symmetric nuclear matter and finite nuclei using Relativistic Mean Field theory with Tomas-Fermi approximation. Work supported by DFG. werden,

HK 33.5 Di 18:00 TU MA041

Mass and Half-life Measurements at FRS-ESR Facilities at GSI — •Yu.A. Litvinov for the FRS-ESR collaboration — GSI Darmstadt — JLU Giessen

Progress and perspectives of mass and lifetime measurements of stored exotic nuclei at GSI are presented.

Exotic nuclei were produced via projectile fragmentation and fission and separated in flight with the fragment separator FRS. The spatially separated fragments were injected into the storage-cooler ring ESR. The energies, up to 900 MeV/u, were high enough to produce bare and few-electron projectile fragments for all elements. This allows to investigate nuclear decay properties under conditions which prevail in hot stellar plasmas. Dramatic prolongations of nuclear lifetimes and the open branch of bound-state beta decay for bare ions have been observed.

Masses have been measured with Schottky (SMS) and Isochronous (IMS) Mass Spectrometry for stored fragments. SMS requiring electron cooling has a lower limit for lifetimes of the order of a few seconds. 114 new masses of neutron-deficient isotopes in the lead region have been measured with time-resolved SMS with an improved accuracy of typically 1.5×10^{-7} (30 μu). Neutron-rich uranium projectile fragments were measured in the element range from neodymium to uranium. New long-lived K-isomers are expected in the A=180 mass region. New masses of short-lived neutron-rich fission fragments have been obtained with IMS which yields access to nuclei with lifetimes down to the sub-millisecond range. The experimental results will be compared with theoretical predictions.

HK 33.6 Di 18:15 TU MA041

Bestimmung von Wirkungsquerschnitt und Tensoranalysierstärke A_{yy} in SCRE-Konfigurationen der Reaktion ^{1}H($\vec{d}$,pp)n bei 19 MeV — • J. Ley[1], C. D. Düweke[1], R. Emmerich[1], A. Imig[1], H. Paetz gen. Schieck[1] und H. Witała[2] — [1]IKP, Universität zu Köln, Germany — [2]Jagellonian University Cracow, Poland

In der SCRE (**S**ymmetric **C**onstant **R**elative **E**nergy)-Geometrie werden im Schwerpunktsystem alle drei Nukleonen der dp-Aufbruchreaktion unter Relativwinkeln von 120° emittiert, wobei sie alle die gleiche kinetische Energie erhalten. Die beiden Protonen liegen symmetrisch zu einer Fläche, die aus der Strahlachse und dem austretenden Neutron gebildet wird. Der SCRE-Endzustand kann im Schwerpunktsystem durch den Winkel α zwischen der umgekehrten Strahlrichtung und dem ausgehenden Neutron charakterisiert werden. Die Voraussagen von Wirkungsquerschnitten und Tensoranalysierstärken A_{yy} basieren auf dem Dreinukleonen-Faddeev-Formalismus, wobei moderne Präzisions-NN-Mesonenaustauschpotentiale verwendet werden. Älte-

re dp-Aufbruchdaten bei $E_{\vec{d}} = 94.5\,\mathrm{MeV}$ [1] und $E_{\vec{d}} = 52.1\,\mathrm{MeV}$ [2] hatten für die Tensoranalysierstärke signifikante Abweichungen von theoretischen Vorhersagen gezeigt. Um zu untersuche! n, ob solche Observable auch bei niedrigen Energien Abweichungen zeigen, wurden vier SCRE-Situationen bei $E_{\vec{d}} = 19\,\mathrm{MeV}$ gemessen. Die Ergebnisse werden vorgestellt.
Gefördert durch die DFG.
[1] H. Witała et al., Phys. Rev. C **52** (1995) 2906
[2] L.M. Qin et al., Nucl. Phys. A **587** (1995) 252

HK 33.7 Di 18:30 TU MA041

Fusion of heavy nuclei for the formation of superheavy elements — •Alexis Diaz-Torres[1,2], Carsten Greiner[1], Walter Greiner[1], and Werner Scheid[2] — [1]Institut für Theoretische Physik der Johann Wolfgang Goethe-Universität Frankfurt, Robert Mayer 10, D-60064 Frankfurt am Main, Germany — [2]Institut für Theoretische Physik der Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, D-35392 Giessen, Germany

In my talk I would like to discuss the mechanism of formation of the compound nucleus in the fusion of heavy ions leading to superheavy elements. The ideas are based on a quantum-statistical approach that makes use of (i) a master equation for the probability distribution of the nuclear shapes, and (ii) the two-center shell model to obtain the microscopic ingredients of the theory. Some examples of cold and hot fusion reactions will be presented and discussed.