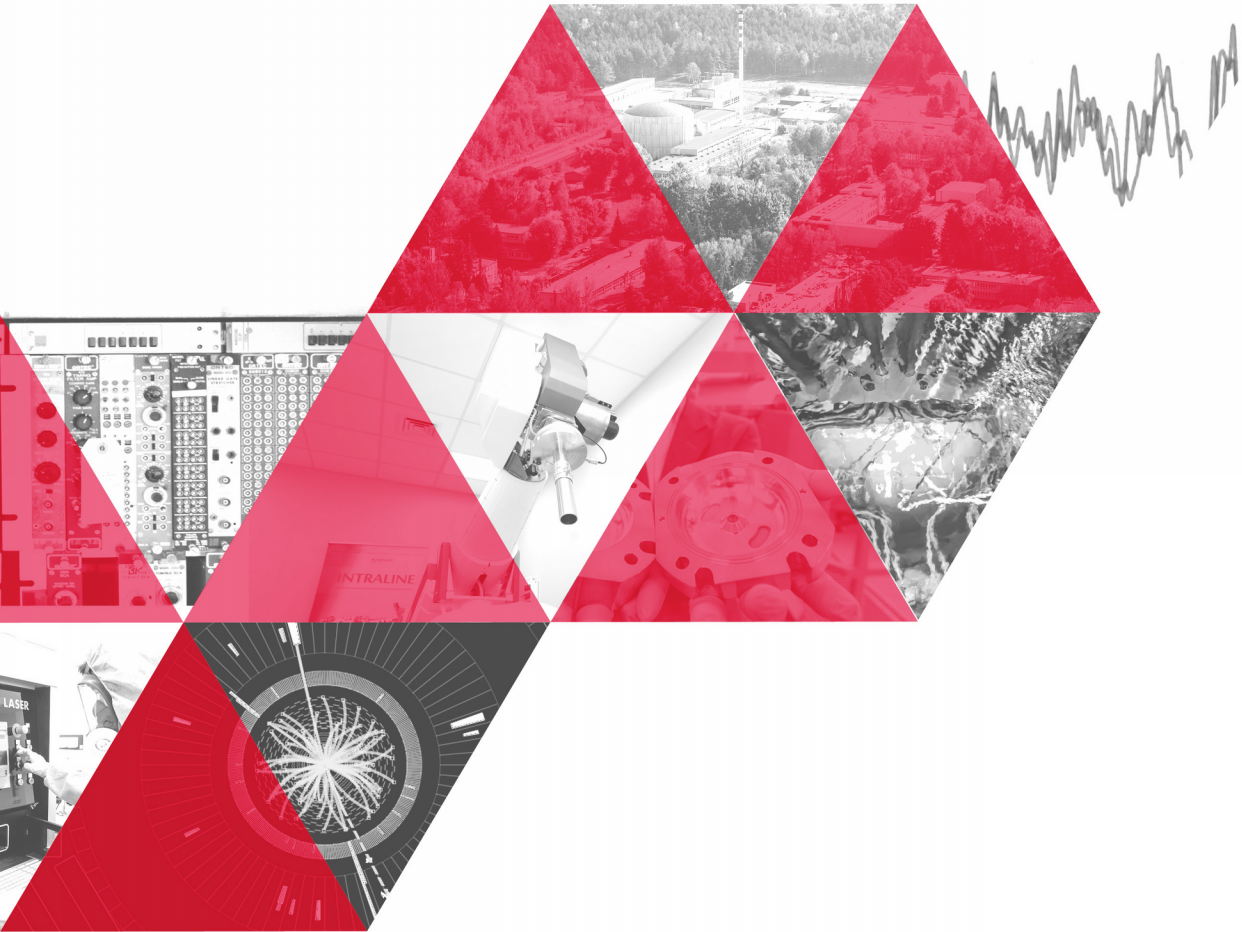
Direct Reactions Induced by Light Nuclei

Nicholas Keeley



NARODOWE CENTRUM BADAŃ JĄDROWYCH
ŚWIERK

Activities in 2017

9 papers published in refereed journals, 8 in Phys. Rev. C, 1 in Eur. Phys. J. A.

Invited talk at the 4th Workshop of the Hellenic Institute of Nuclear Physics, Ioannina, Greece, "*Light charged particle production in reactions induced by weakly-bound projectiles: Still an open question*"

Attendance at the XXXV Mazurian Lakes Conference on Physics, Piaski, Poland

Member of the Scientific Council of NCBJ

Member of the Programme Advisory Committee of HIL, University of Warsaw

Member of the Ph.D. Examination Board for Mr. O. Sgouros, University of Ioannina, Greece

Refereeing activities: NPA, 2 manuscripts, 3 reports; EPJA, 4 manuscripts, 5 reports; PRC, 5 manuscripts, 6 reports, APPB, 2 manuscripts, 4 reports.

Participation in an experiment at CERN-ISOLDE to measure the $^{15}C + ^{208}Pb$ elastic scattering at a near-barrier energy

Collaboration visits to CEA Saclay, France and University of Padua, Italy funded by COPIGAL and POLITA umbrella grants (one paper submitted and one in preparation)

Three further papers in various stages of the review process, submitted to Phys. Rev. C

Work performed in collaboration with colleagues from Poland, France, Greece, Italy, India, Spain, United States and United Kingdom

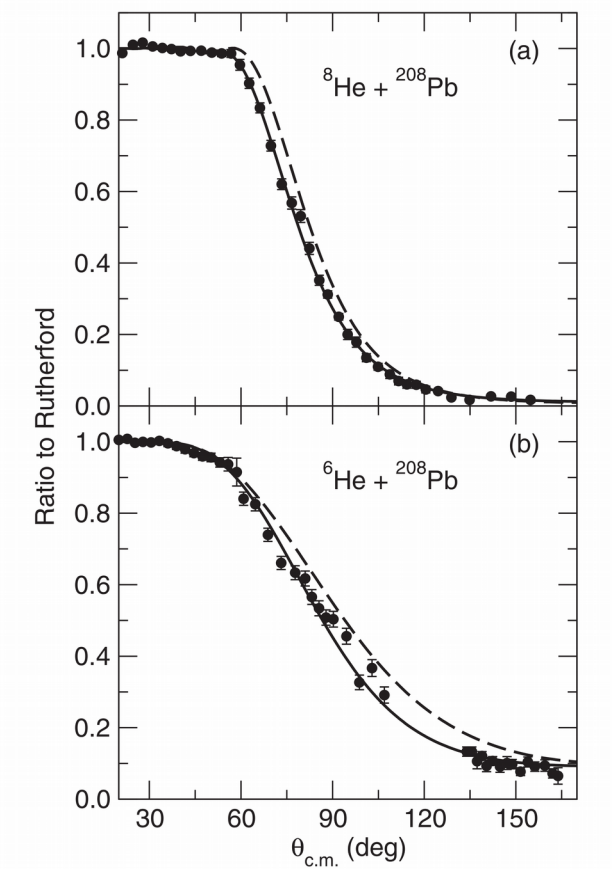
Influence of single-neutron stripping on near-barrier ^{6}He+^{208}Pb and ^{8}He+^{208}Pb elastic scattering

Published as: G. Marquínez-Durán *et al.*, Phys. Rev. C **95**, 024602 (2017).

New, high quality data for the elastic scattering of 22 MeV ^{8}He from ^{208}Pb, together with existing similar data for ^{6}He, enabled a comparative study of single-neutron stripping coupling effects for these two exotic He isotopes.

Concentrate on 1n-stripping: should be stronger for ^{8}He and can be accurately modelled

Effects of other couplings absorbed into optical model potential



Strategy: fit data with optical model potential (Woods-Saxon form) then re-fit (minimise χ^2) with 1n-stripping couplings explicitly included

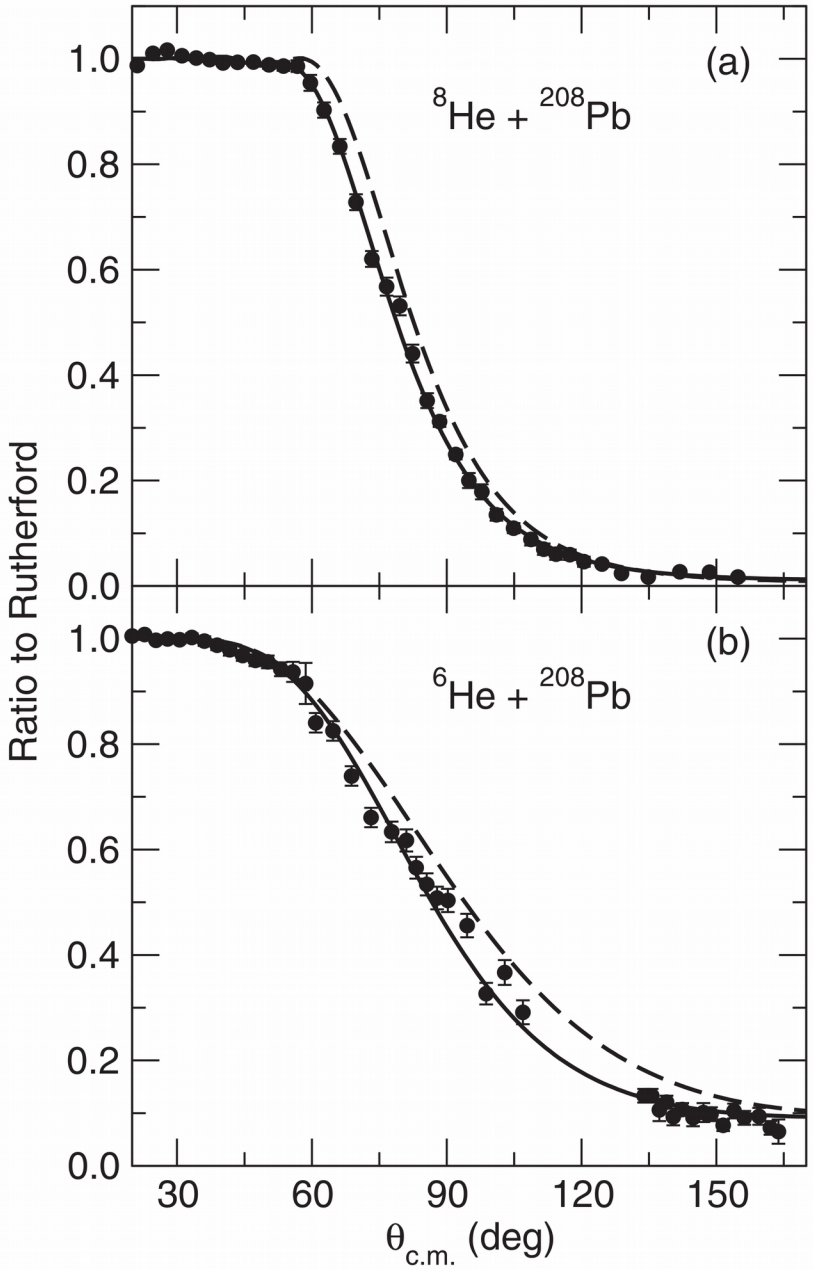
This can be done with searching form of coupled reaction channels (CRC) code FRESCO.

In fact, we find that it is only necessary to reduce depth of imaginary part of optical potential (*W*) in order to recover fit to data in CRC calculation

Couplings are for stripping leading to the 7 strong single-particle levels of ^{209}Pb and account for about 37% and 21% of the imaginary potential for ^{8}He and ^{6}He respectively.

In figures:

for ^{8}He total reaction cross section = 1525 mb, 1n-stripping cross section = 243 mb
for ^{6}He total reaction cross section = 1412 mb, 1n-stripping cross section = 219 mb



The figure shows the effect of coupling to 1n stripping: full curves are complete CRC results and dashed curves show effect of switching off the stripping couplings.

Note effect of coupling in the “Coulomb rainbow” region for ^{8}He but not for ^{6}He. Also note that coupling effect persists to larger angles for ^{6}He.

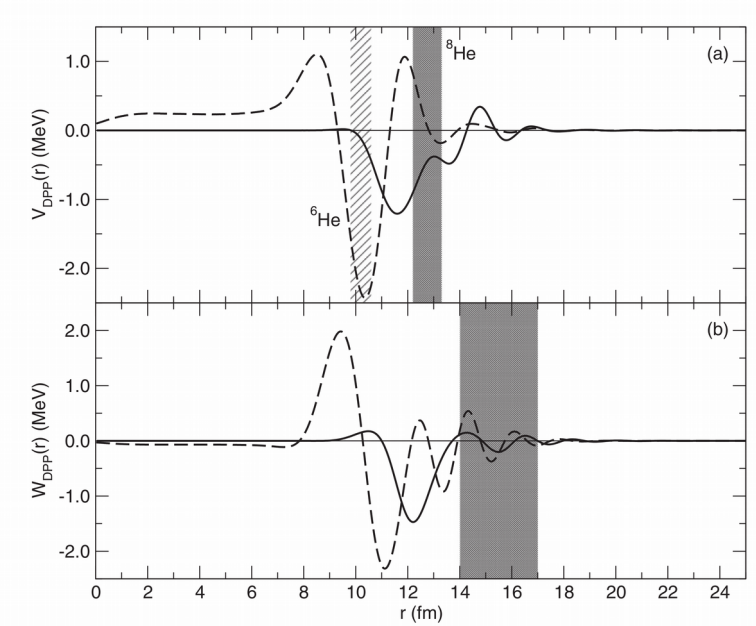
All other things being equal (as here) one would expect the stripping cross sections for ^{8}He and ^{6}He to scale with the difference in projectile overlap spectroscopic factors (roughly a factor of 2).

Not the case; the cross sections depend on the choice of exit channel OMP but the coupling effect fortunately does not!

Note that both ^{8}He and ^{6}He have *very* diffuse imaginary potentials (a > 1.0 fm) which seems to be mainly due to the effect of breakup (at least in the case of ^{6}He).

This leads to some peculiarities in the fitting; the ^{6}He data are not very sensitive to the real part of the potential, the ^{8}He somewhat more so. The long “tail” in the imaginary (absorptive) part seems to “mask” the real part.

However, we can extract an equivalent potential from our full CRC calculations and by subtracting the “bare” optical potential we get an idea of the explicit contribution of the stripping coupling to the optical model potential:



Main result of this exercise is that the absorption generated by 1n-stripping coupling appears at a larger radius for ^{8}He than for ^{6}He.

This is in contrast to the *total* absorption as evidenced by the distance of closest approach at which the elastic scattering first deviates significantly from Rutherford. much larger for ^{6}He than for ^{8}He.

This suggests that the optical model absorption is dominated by the long-range effect of coupling to breakup, which should be more important for ^{6}He than for ^{8}He (lower breakup threshold and stronger dipole coupling to continuum).

Stripping coupling also generates significant contribution to *real* part of OMP but data are not sensitive to this.

These data demonstrate that it is feasible to obtain accurate elastic scattering data near the Coulomb barrier with beam intensities as low as 10^{5} pps on target and that such data can reveal significant effects linked to the specific nuclear structure of the projectile.