Elastic backscattering measurements and optical potential analysis for the systems $^{6,7}Li + ^{58}Ni, ^{116,120}Sn, ^{208}Pb$ at sub- and near – barrier energies

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Outline

- Motivation
- Experimental setup
- The results: Determination of barrier distribution via elastic scattering

  Optical potential analysis
- Conclusion: Optical Potentials

  Reaction mechanisms

Motivation

Elastic backscattering measurements are valuable tool for:

- Probing the nuclear potential at sub and near barrier energies
- Probing reactions mechanisms connected with direct procedures

↓

Excitation functions of σ/σ_R

Determination of barrier distributions

Motivation

Previous experiment ⇒

$$^{6,7}Li+{}^{28}Si$$

$$E_{lab}/V_{bar} = 0.6-1.3$$

PRC 80, 017601 2009

PRC 82, 044607 2010

Conclusion:

Backscattering technique is a more accurate technique to probe the optical potential than the conventional angular distribution

Current work ⇒

$$^{6,7}Li+{}^{208}Pb,{}^{116,120}Sn,{}^{58}Ni$$

$$E_{lab}/V_{bar} = 0.6-1.3$$

Experimental setup

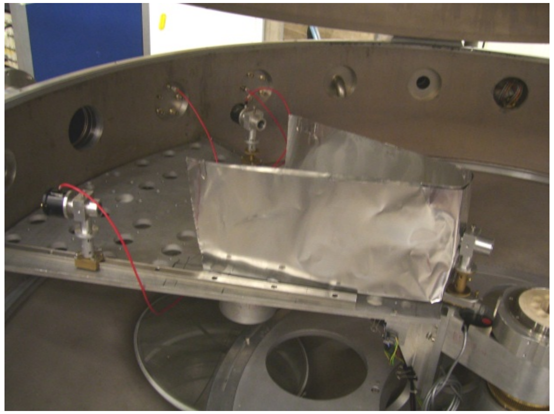
Details:

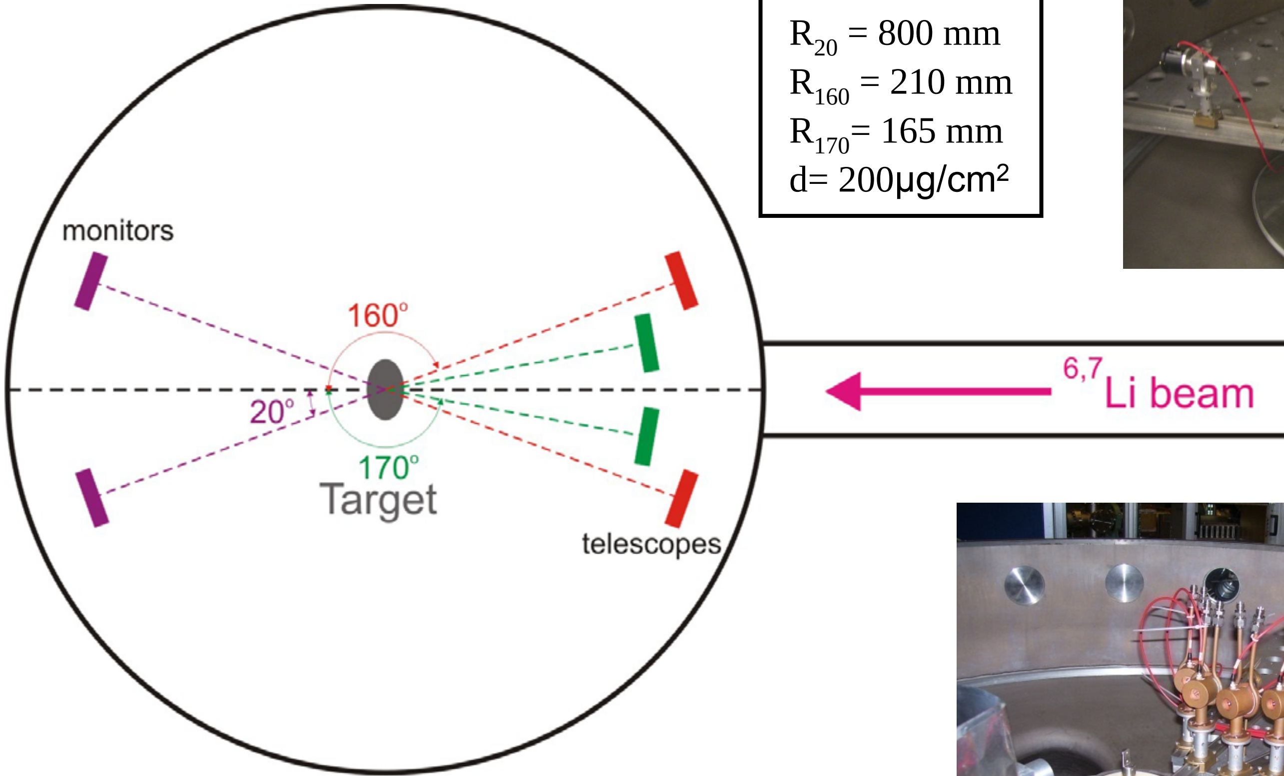
R_{20} = 800 mm

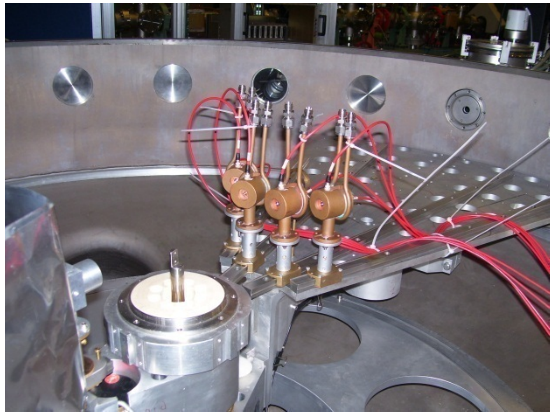
R_{160} = 210 mm

R_{170}= 165 mm

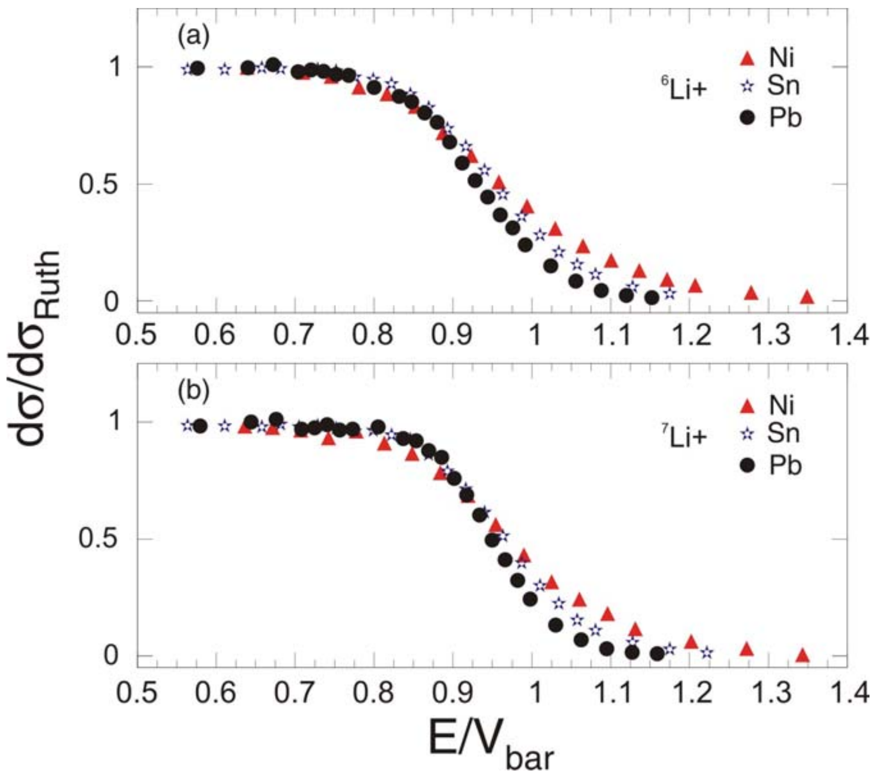
d= 200μg/cm^2

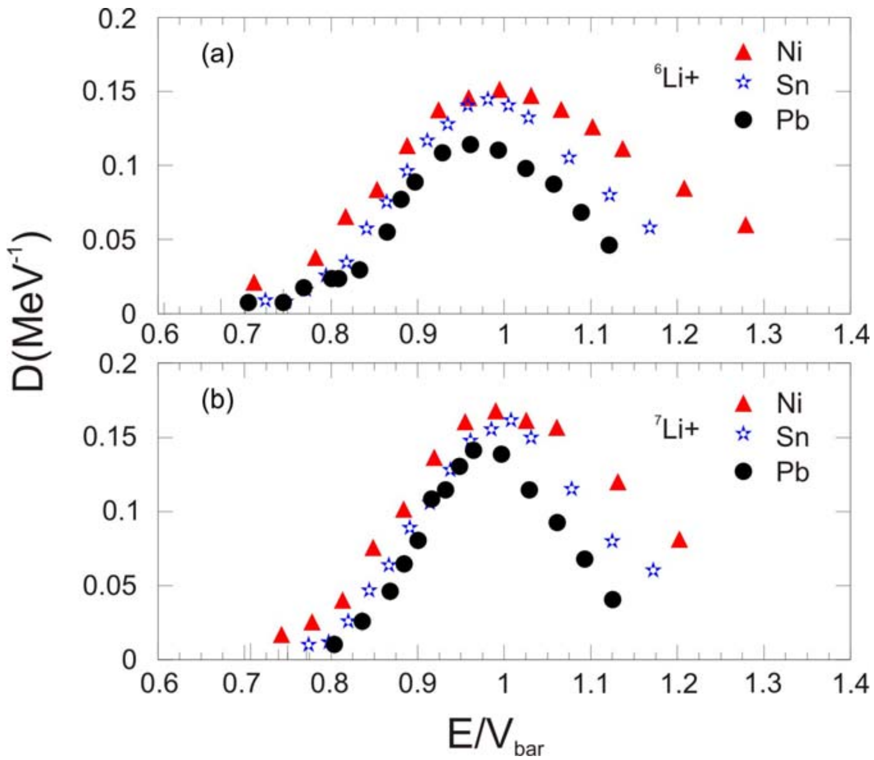






Barrier distribution via elastic scattering





$$\frac{\sigma_{el\,(170^o)}}{\sigma_{Ruth\ (170^o)}}(E)=\frac{N_B\cdot\Omega_F\cdot\sigma_{Ruth\ (30^o)}}{N_F\cdot\Omega_B\cdot\sigma_{Ruth\ (170^o)}}(E)$$

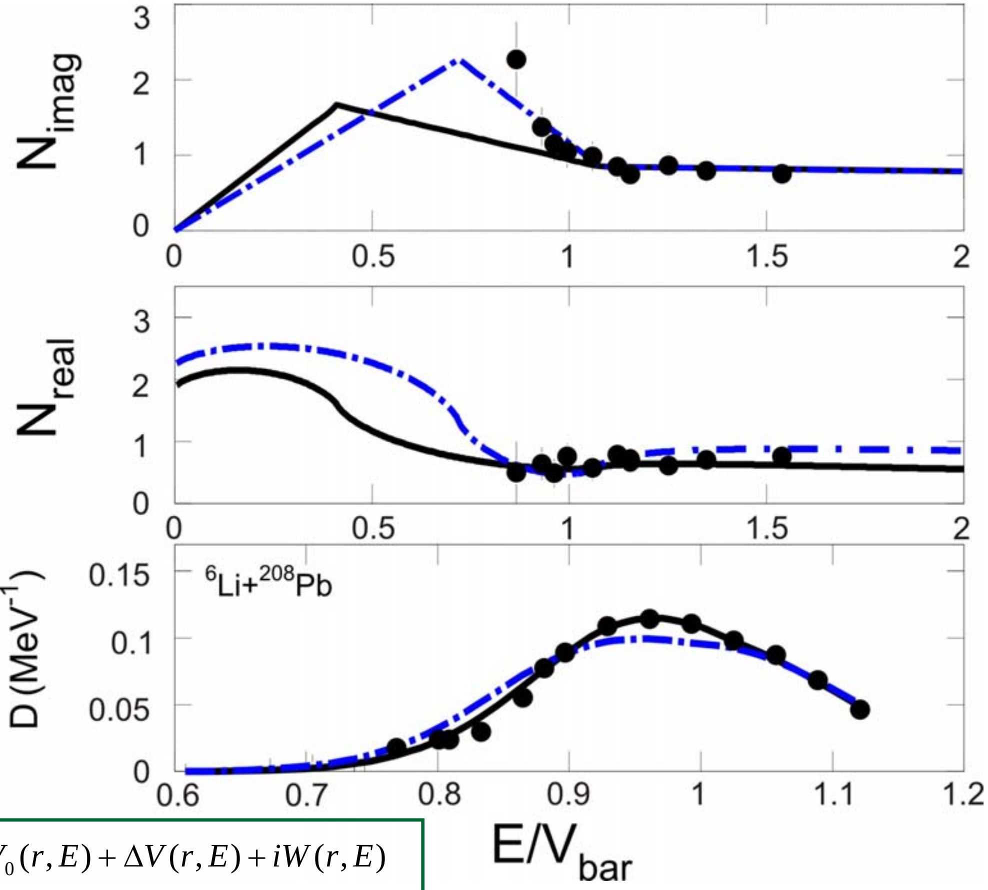
$$D_{el}(E)=-\frac{d}{dE}\left[\sqrt{\frac{d\sigma_{el}}{d\sigma_{Ruth}}(E)}\right]$$

Optical model analysis

Starting point: Imaginary potential

Main steps:

- Draw a straight line to define the imaginary potential above the Coulomb barrier.
- Define the energy point where a second line should be drawn.
- Define the slope of the second line.
- Define the last energy point, where the imaginary potential drops to zero.



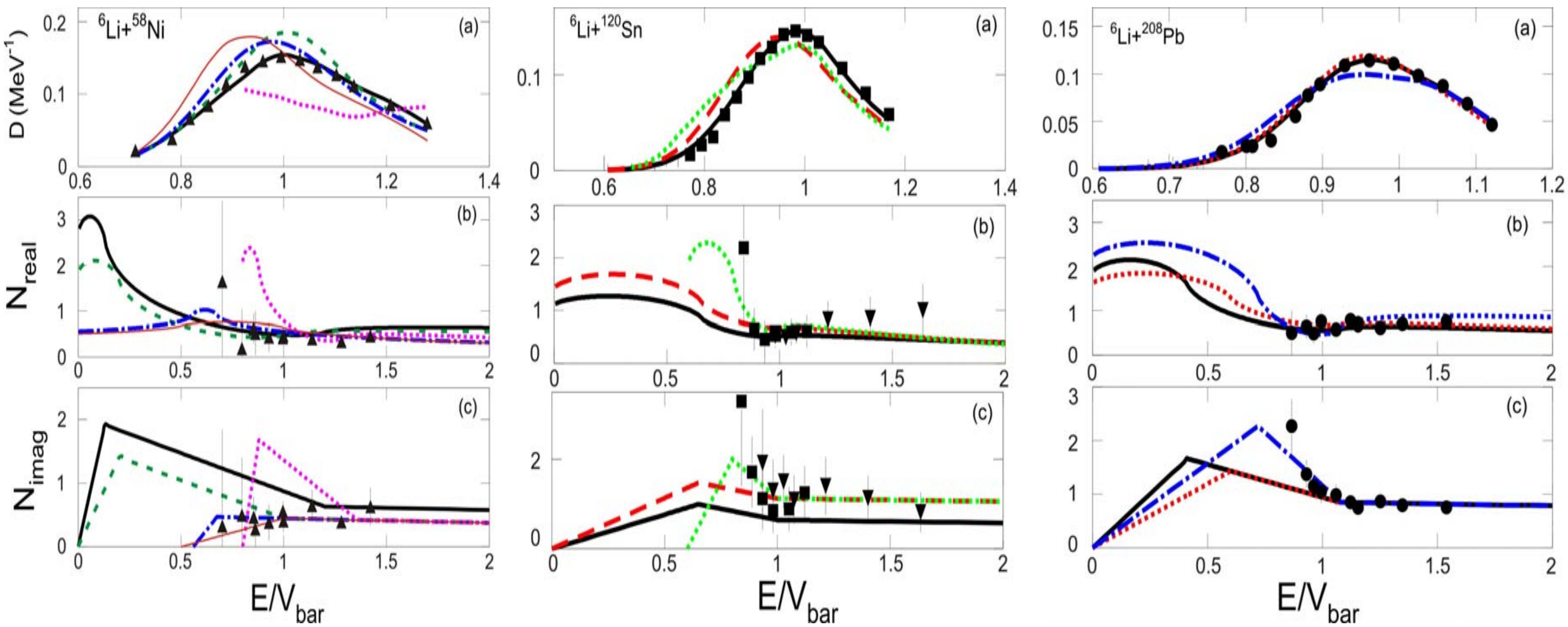
Dispersion relation

$$U(r,E) = V_0(r,E) + \Delta V(r,E) + iW(r,E)$$

$$\Delta V = \frac{P}{\pi}\int_0^\infty \frac{W(r,E)}{E'-E}dE'$$

Optical model analysis

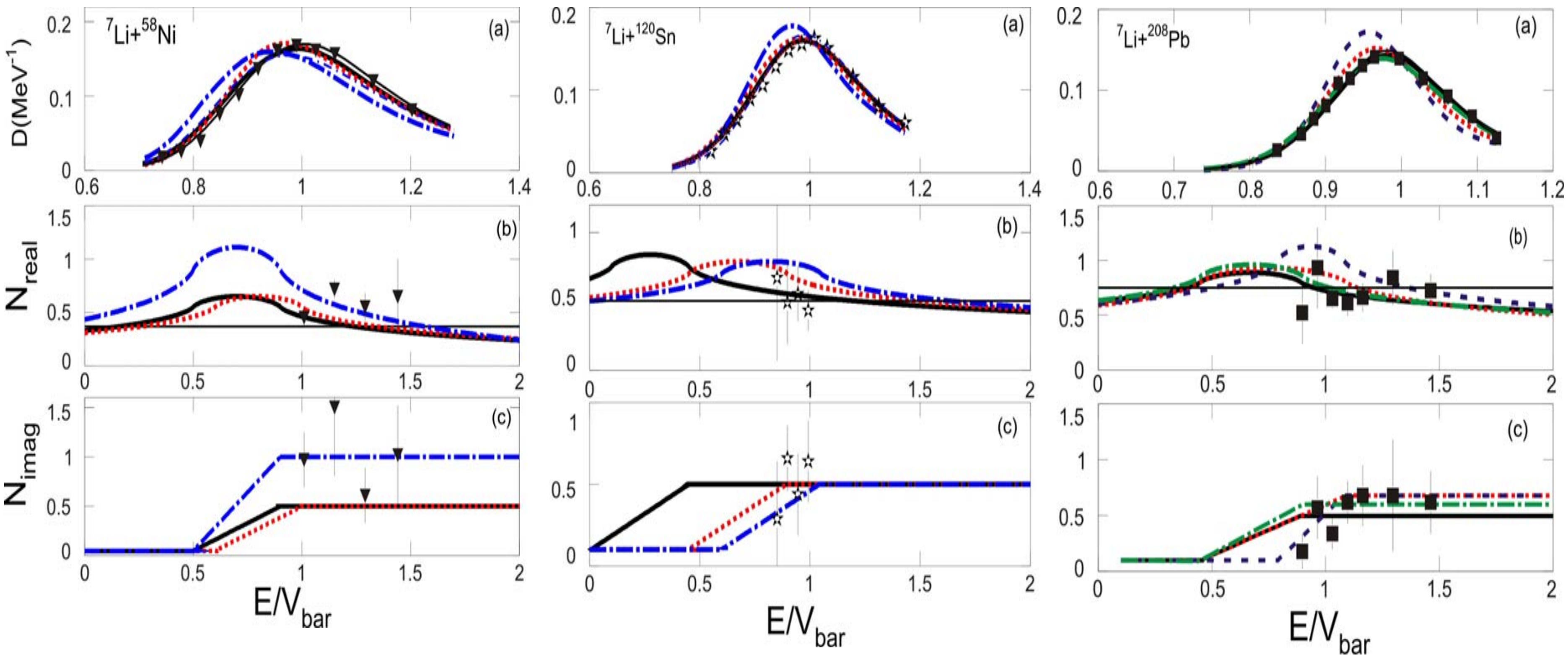
⁶Li on different targets



EPJA Vol.48 (7), p.102, 2012

Optical model analysis

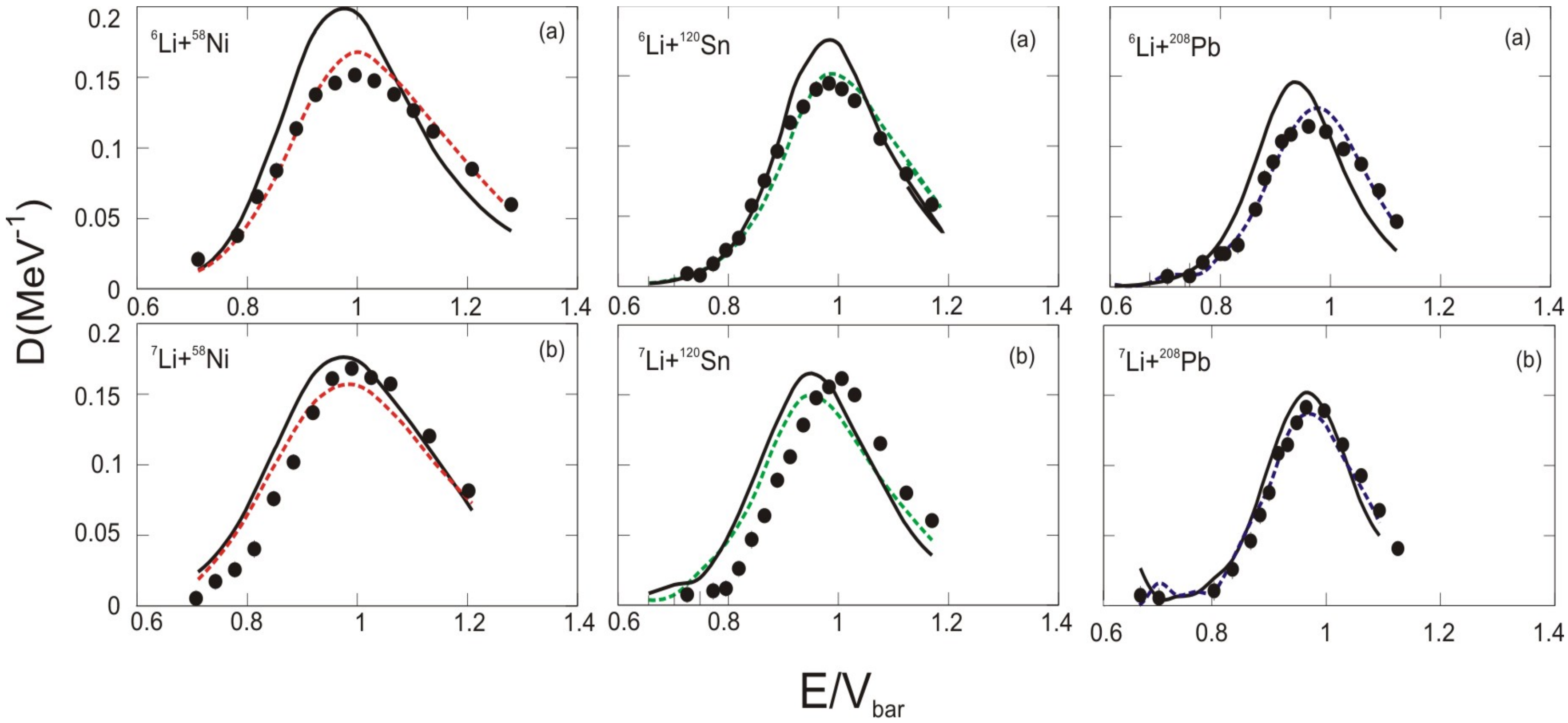
^{7}Li on different targets



EPJA Vol.48 (7), p.102, 2012

Reaction mechanisms

^{6,7}Li on different targets



Calculated by K. Rusek - EPJA Vol.48 (7), p.102, 2012

Conclusions

- **Optical potential**

The backscattering technique is a valuable tool for predicting the optical potential at sub and near barrier energies.

For weakly bound nuclei the imaginary potential persists either with an increasing trend (^{6}Li) or a flat behavior (^{7}Li) to sub-barrier energies near $E/V_{bar}=0.5$

For ^{6}Li the rising part has the larger slope for the heavier targets and the smaller slope for the lighter.

These measurements indicate, especially for ^{7}Li, that the dispersion relation connecting the imaginary and the real part of the optical potential may not be valid to weakly bound nuclei in accordance to initial predictions by Satchler.

- **Reaction mechanisms**

Coupling to the continuum are strong and important.

Collaborators

- University of Ioannina, Greece
- INFN-LNS, Catania, Italy
- Dipartimento di Scienze Fisiche and INFN, Università di Napoli, Italy
- The Andrzej Soltan Institute for Nuclear Studies and Warsaw University, Poland
- CEA SACLAY, France
- Dipartimento di Fisica and INFN , Università di Padova, Italy
- National Institute for Physics and Nuclear Engineering (NIPNE), Romania
- University of Huelva, Spain

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