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Studies of the low energy resonance reactions in the medium mass nuclear systems

Sergey Torilov, Nikolaiy Maltsev, Igor Altsibeev,
Tatiana Lazareva, Dosbol Nauruzbaev, Dmitriy Nesterov, Nikita Prokofiev,
Alina Rakhmatullina, Vladimir Zherebchevsky.

St Petersburg University

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Outline

- Searhing for the new low-energy resonances in the $^{12}C+^{16}O$ system
- Investigation of the qvasimolecular resonancses and rotational bands structure for the parity doublets

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Today there are several methods for determining the angular momentum of the resonances in the heavy ion reactions. Nevertheless, most of the resonance spins that are considered as candidates for quasimolecular states were determined by comparing experimental angular distributions with Legendre polynomials. In present work, the region of angular distribution in the back hemisphere, where the oscillations of the cross section are most clearly manifested, was compared with functions of the form:

$$A \cdot |P_l(\cos\theta)|^2$$

and for the state the angular momentum corresponding to the polynomial with the best approximation was added.

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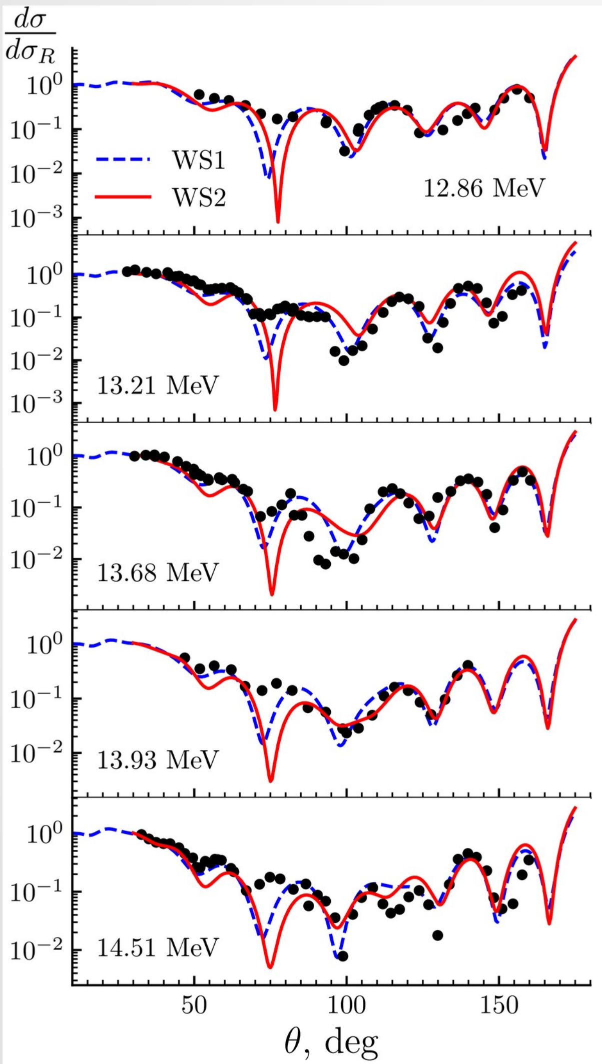
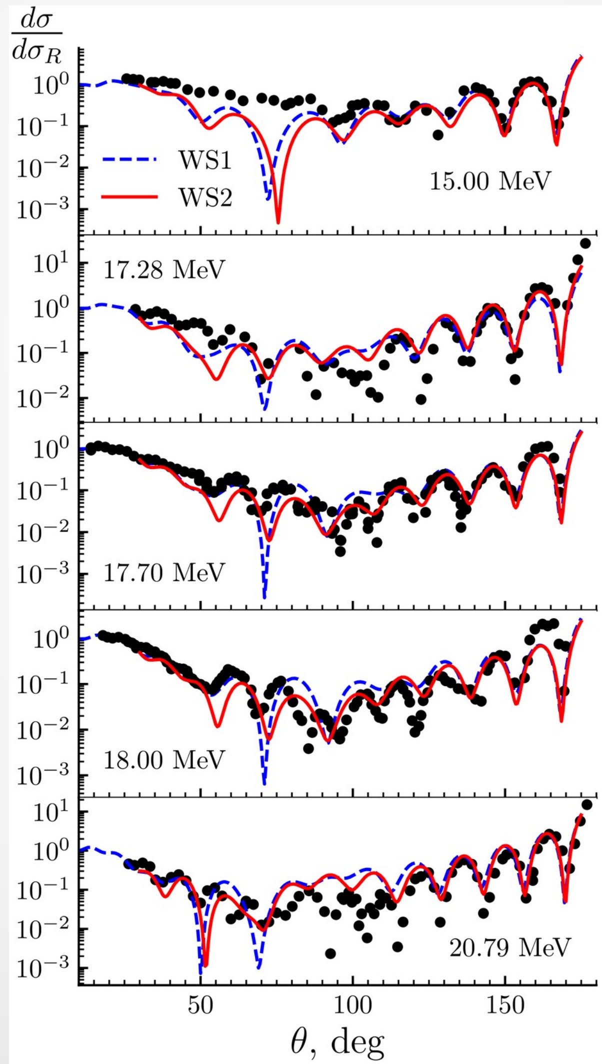
The reaction $^{16}O+^{12}C$ was considered as an example.
The following real part for the potentials were chosen:





Parameter	Value
WS1	
V_0	305 MeV
R_v	4 fm
a_v	1.4 fm
J_v	326 MeV fm^3
WS2	
V_0	320 MeV
R_v	4.184 fm
a_v	1.3 fm
J_v	378 MeV fm^3

Imaginary part — fitting!

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- Comparison with Legendre by D_l

$$D_l = \sum_i \left[\frac{\left(\frac{d\sigma}{d\Omega}\right)_i^{OM} - |P_l(\cos\theta_i)|^2}{\left(\frac{d\sigma}{d\Omega}\right)_i^{OM}} \right]^2$$

- The dependence of D_l on the energy of the incident particle was obtained.
- The sharp minima were obtained for every *l* value!

⬇

Ericson fluctuation at this point can lead to «false» resonance (peak with a polinomial structure for the angular distribution)!

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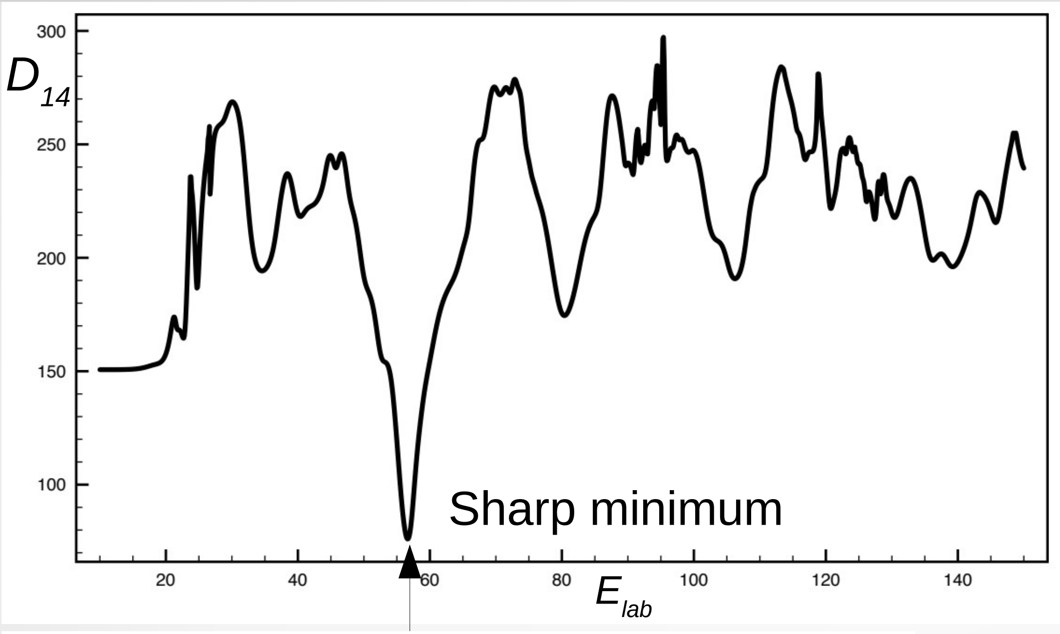

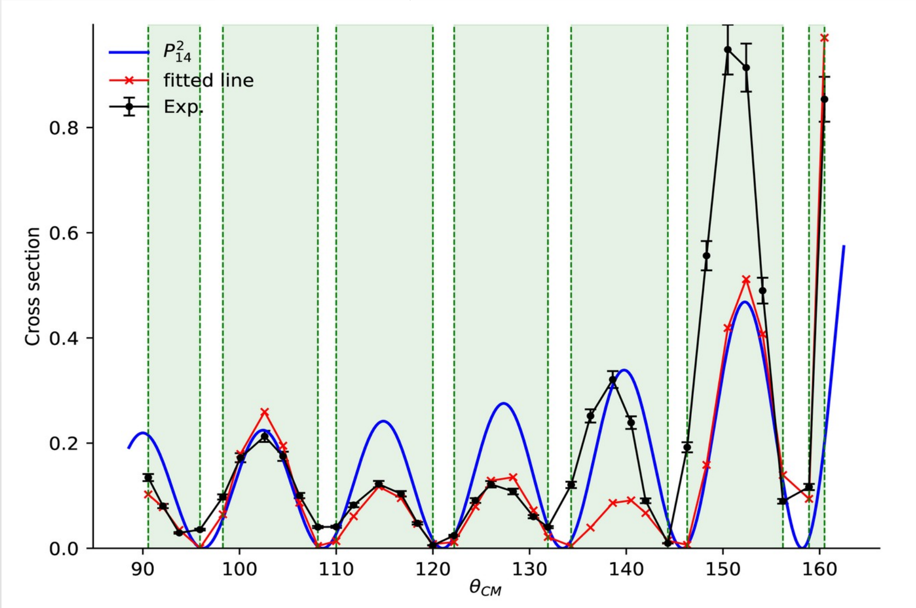

As an example, for *l*=14

Resonance-like angular distributiom for the experimental data. Is it a resonance?
It is possible, but...

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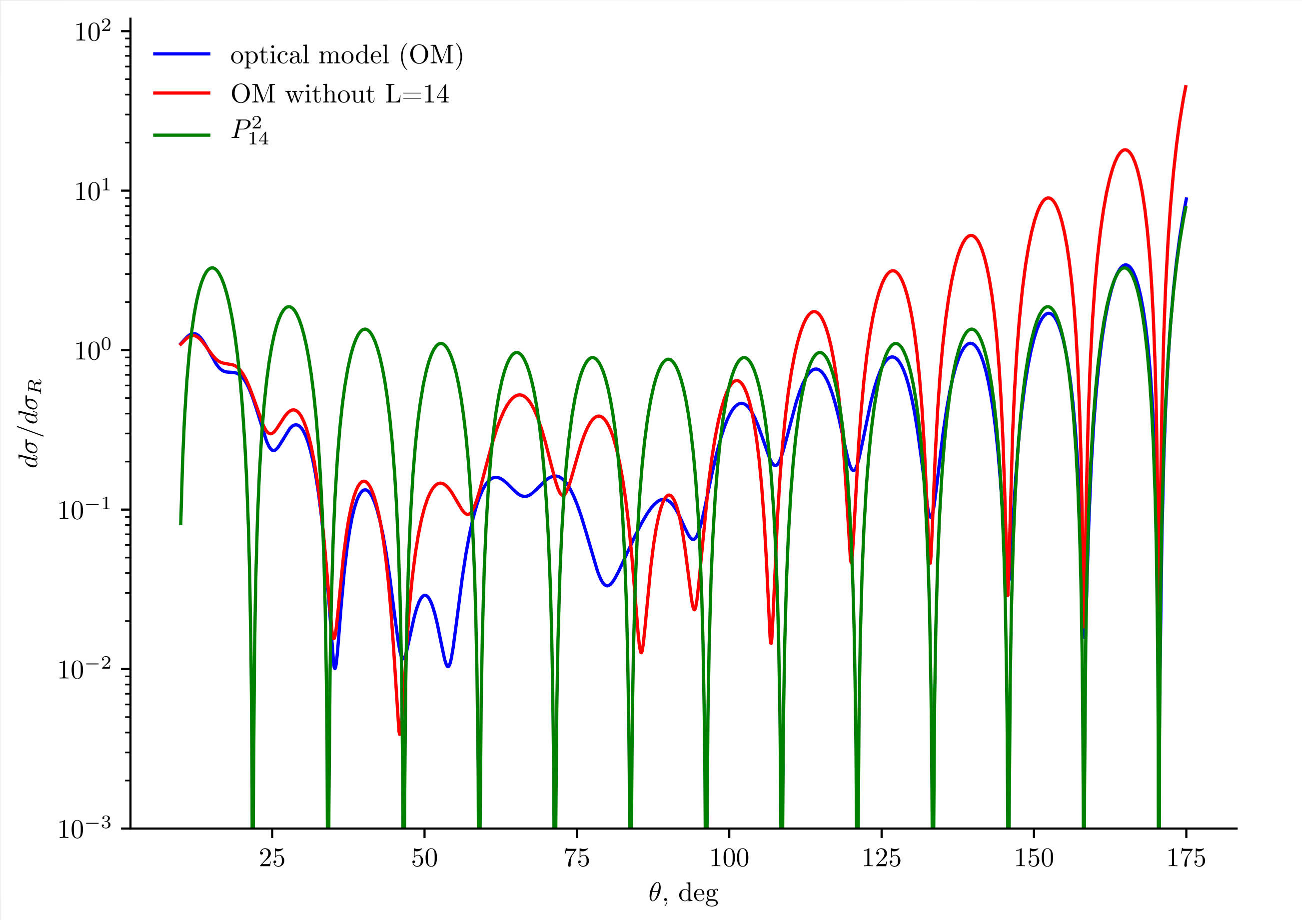

One can obtain the same distribition even without partial wave *l*=14!

The angular distribution has been obtained in the region of the minimum.
Blue and red curves - calculation within the optical model, for a
full set of partial waves and with the exclusion of a partial wave *l* = 14.
The green curve is a 14th order Legendre polynomial.

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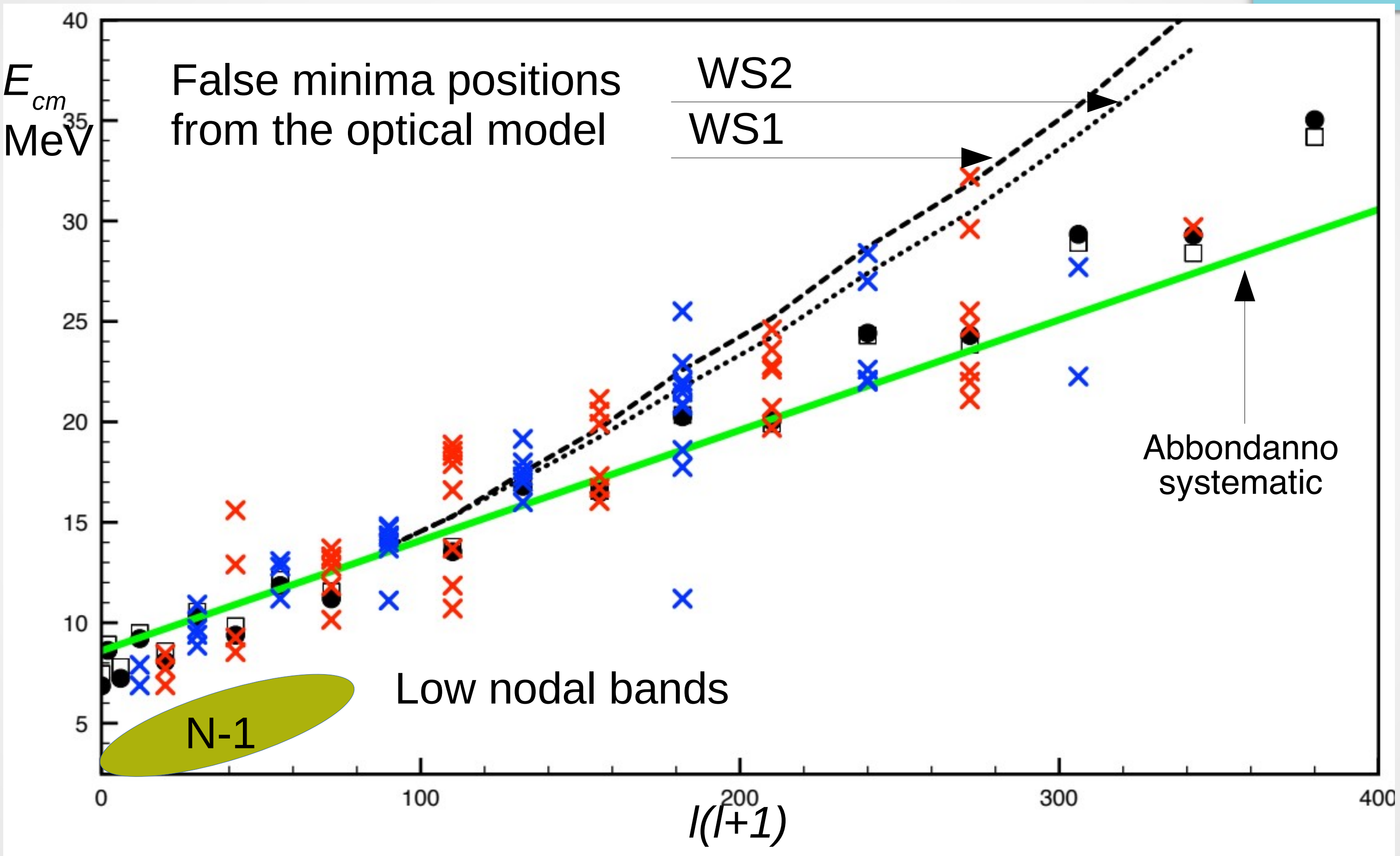

Red and blue crosses are states with positive and negative parity, respectively. Circles and squares, states calculated within the potential model with parameters WS1 (N=22-23) and WS2 (N=24-25), respectively.

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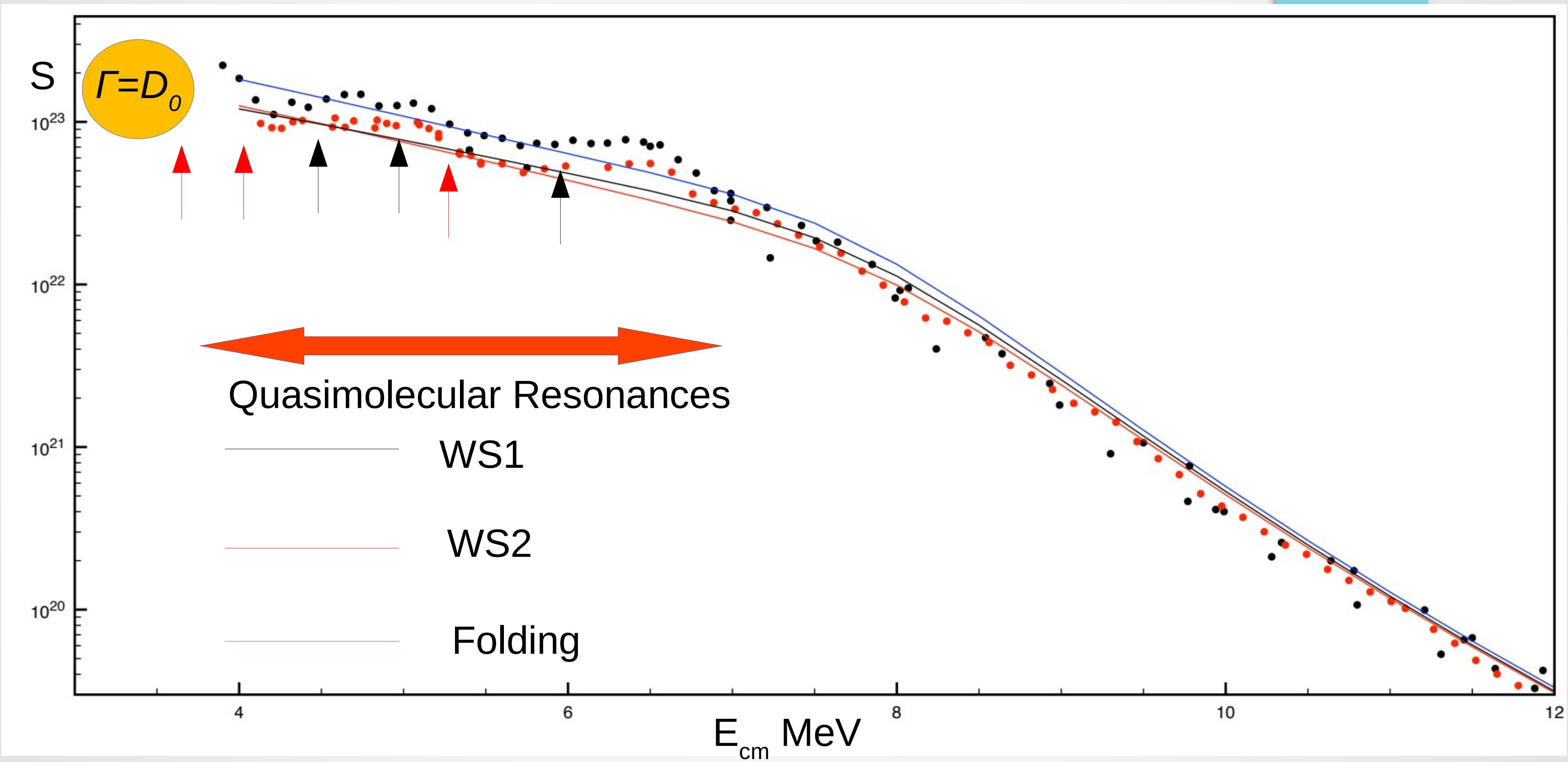

Astrophysical S-factor as function of the center of mass energy.
Points — experimental data. $\Gamma=D_0$ — area where widths of the compound states are smaller than their average spacing. Red and black arrows are prediction of the resonances for N-1 band for WS1 and WS2 respectively.

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Conclusions:

- It was shown that at analyzing the angular distributions in a system of heavy ions, an erroneous detection of resonance is possible.

- It is assumed that single-particle quasi-molecular resonances appear on the $^{12}C+^{16}O$ fusion cross sections in the energy area from 3 to 6 MeV.