Line Shape of the First Excited State in ^{9}Be from High-Resolution Electron Scattering *

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- Motivation
- Experiments
- Results
- Summary and outlook

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Motivation

- ^{9}Be is a loosely bound nuclear system consisting of 2 α and a neutron

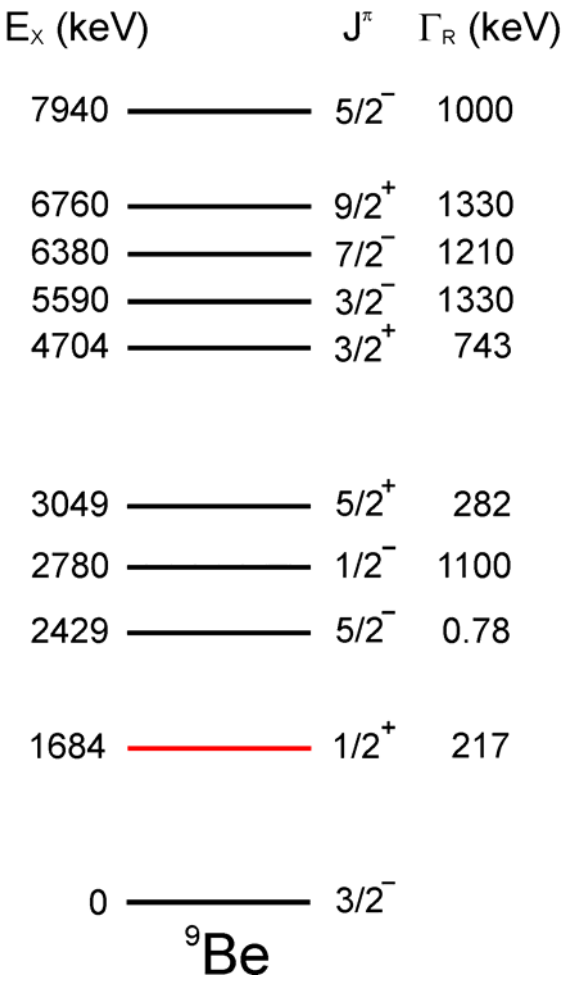
- ^{9}Be is the lightest nucleus having the lowest neutron threshold (S_n= 1.665 MeV) of all stable nuclei

  → first excited states lies at some tens of keV above S_n

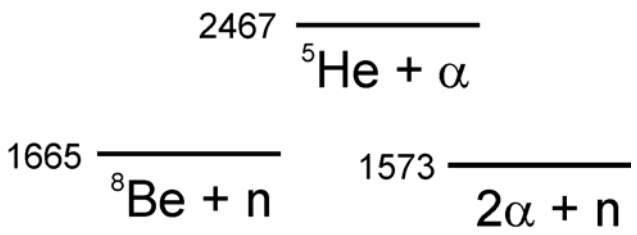
  → all excited states are unstable with respect to neutron decay

- $\alpha + \alpha + n \rightarrow {}^{9}\mathrm{Be} + \gamma$ plays a key role in bridging the unstable mass gaps *A* = 5 and 8 in some astrophysical scenarios

Motivation



- The photodisintegration cross section at low energies is given by the properties of ½⁺ resonance
- Strongly asymmetric line shape
- Resonance parameters from different experiments are not in mutual agreement



One-Level Approximation of *R*-Matrix Theory

$$\sigma_{\gamma,n}(E_x; I \rightarrow J) = \pi \frac{2I+1}{2(2J+1)} \left(\frac{\hbar c}{E_x}\right)^2 \frac{\Gamma_\gamma \Gamma_n}{(E_x - E_R)^2 + \left(\frac{\Gamma}{2}\right)^2}$$

$$\Gamma_\gamma = \frac{16\pi}{9} \alpha (\hbar c)^{-2} E_x^3 B(E1) \qquad \Gamma_n = G_n \sqrt{E_x - S_n}$$

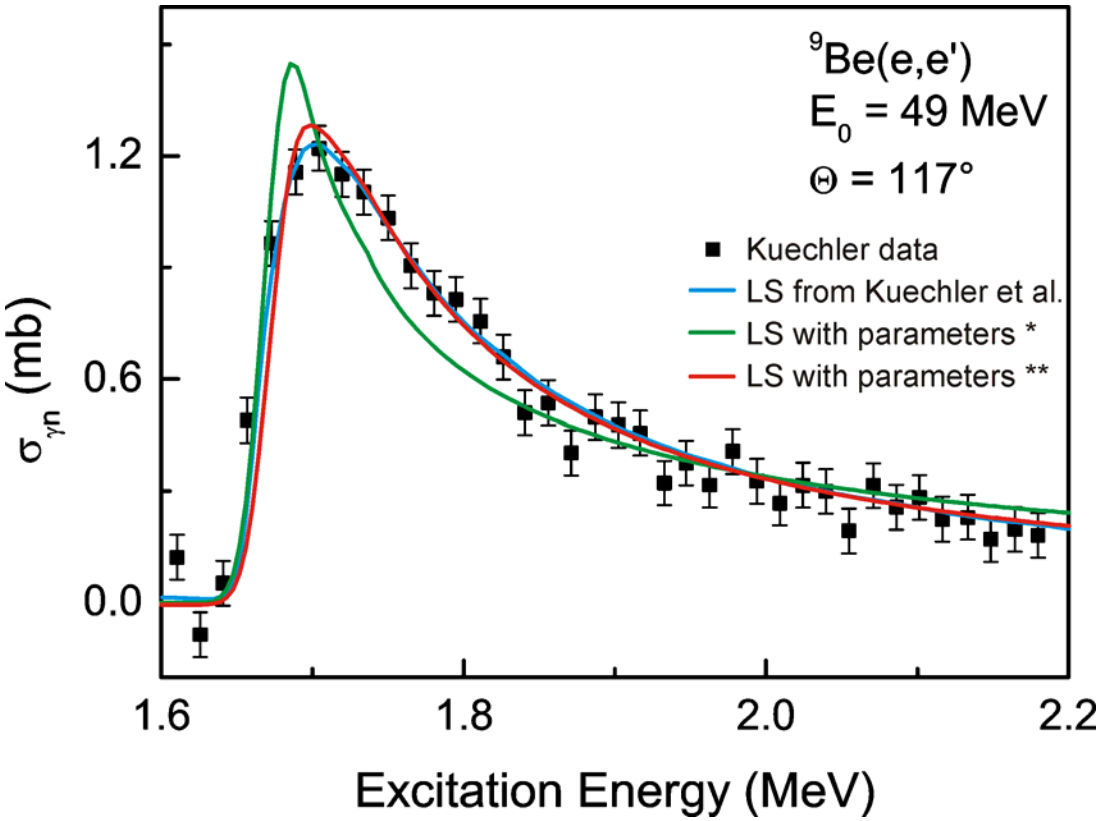
$$\Gamma_n \gg \Gamma_\gamma \qquad \Gamma \simeq \Gamma_n$$

$$\sigma(E_x) = Const \times \frac{E_x G_n \sqrt{E_x - S_n}}{(E_x - E_R)^2 + \frac{G_n^2 (E_x - S_n)}{4}}$$

Parameter values for fits to $^{9}Be(\gamma,n)^{8}Be$ data extracted from (e,e´)

- Barker, Aust. J. Phys. 53 (2000) 247
  - → E_R = 66 keV
    Γ_R = 280 keV
- Kuechler et al., Z. Phys. A 326 (1987) 447
  - → E_R = 19 keV
    Γ_R = 217 keV

Reanalysis of Old (e,e´) Data



Kuechler et al., Z. Phys. A 326 (1987) 447

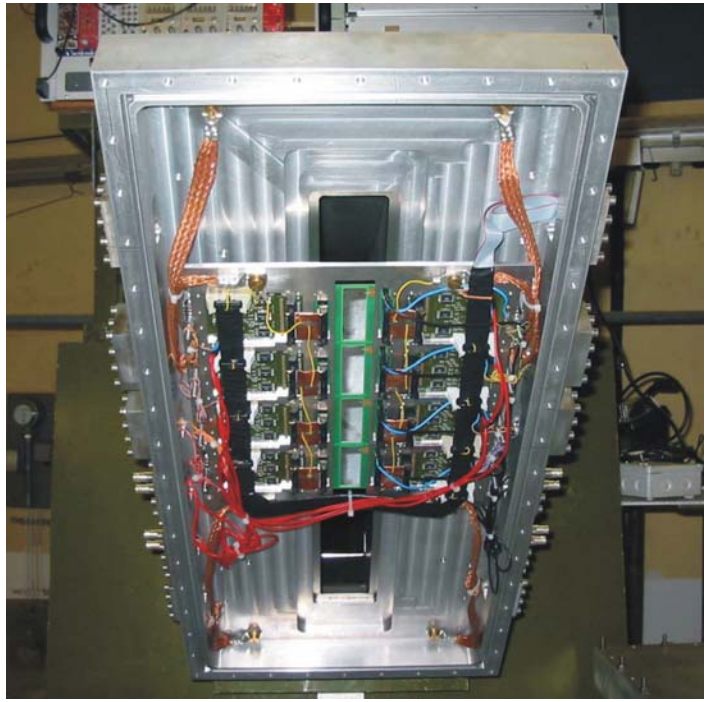
* E_R = 19 keV
Γ_R = 217 keV

Barker, Aust. J. Phys. 53 (2000) 247

** E_R = 66 keV
Γ_R = 280 keV

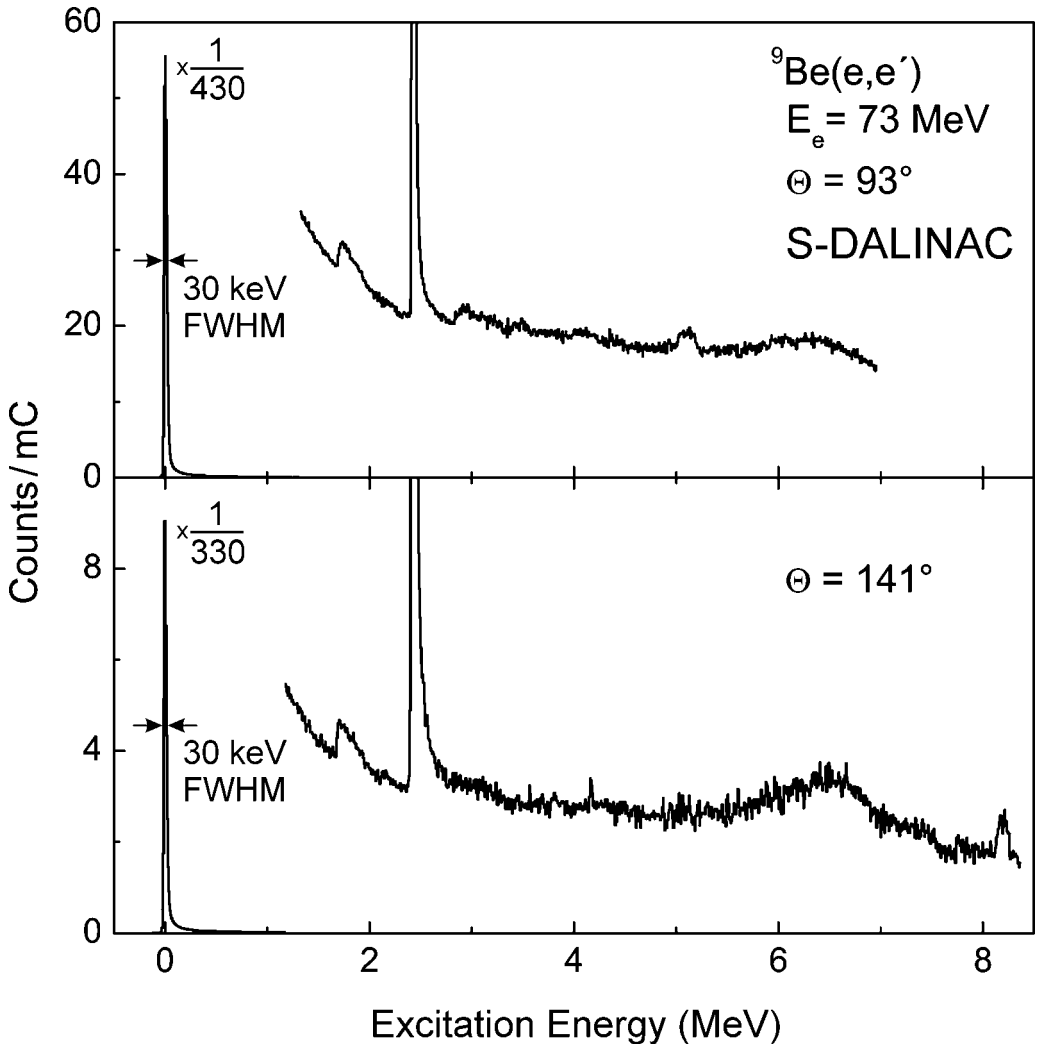
- Line shape parameters of Barker confirmed

Energy-Loss Spectrometer at the S-DALINAC

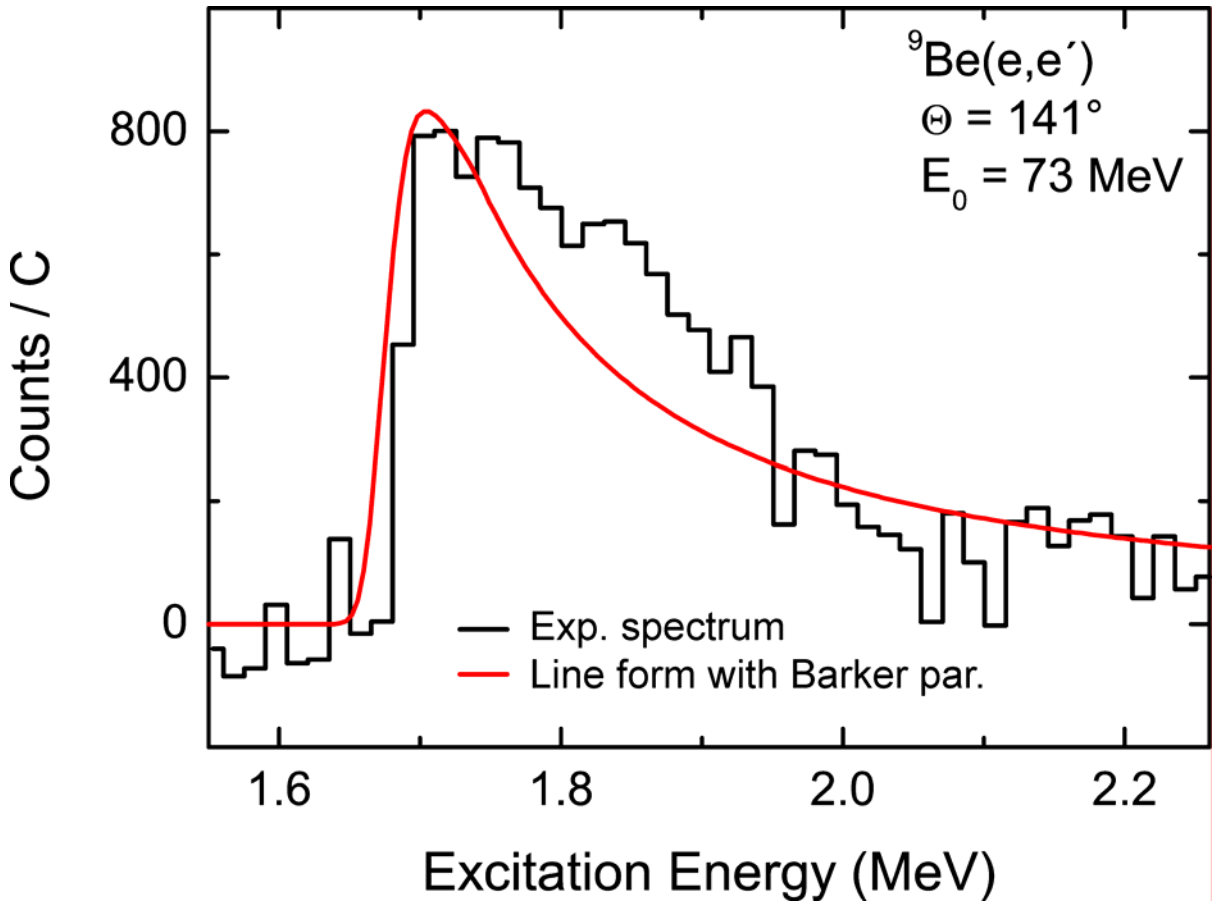


- Si microstrip detector system: 4 modules, each 96 strips with pitch of 650 μm
- Count rate up to 100 kHz
- High spatial resolution 1.5×10^{-4}

Data

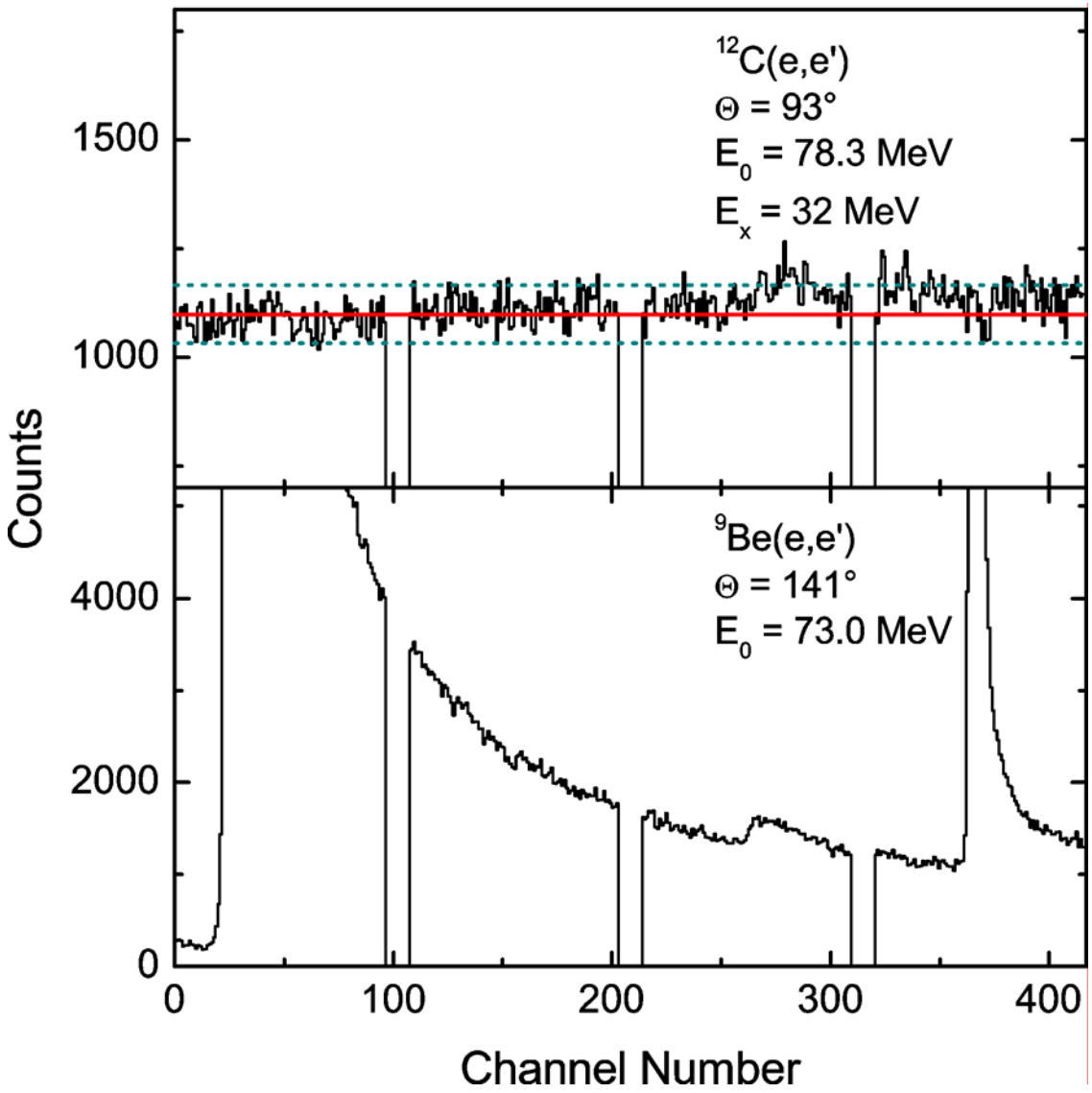

60
40
20
0
8
4
0
2
4
6
8
Counts / mC
Excitation Energy (MeV)
x 1/430
x 1/330
30 keV FWHM
30 keV FWHM
9Be(e,e´)
Ee = 73 MeV
Θ = 93°
S-DALINAC
Θ = 141°

½⁺ State



- Efficiency problem of the detectors?

Efficiency Measurement: “White” Spectra



Summary and Outlook

- Line shape parameters of Barker for old (e,e´) data confirmed
- Analysis of the new high-resolution (e,e´) data in progress