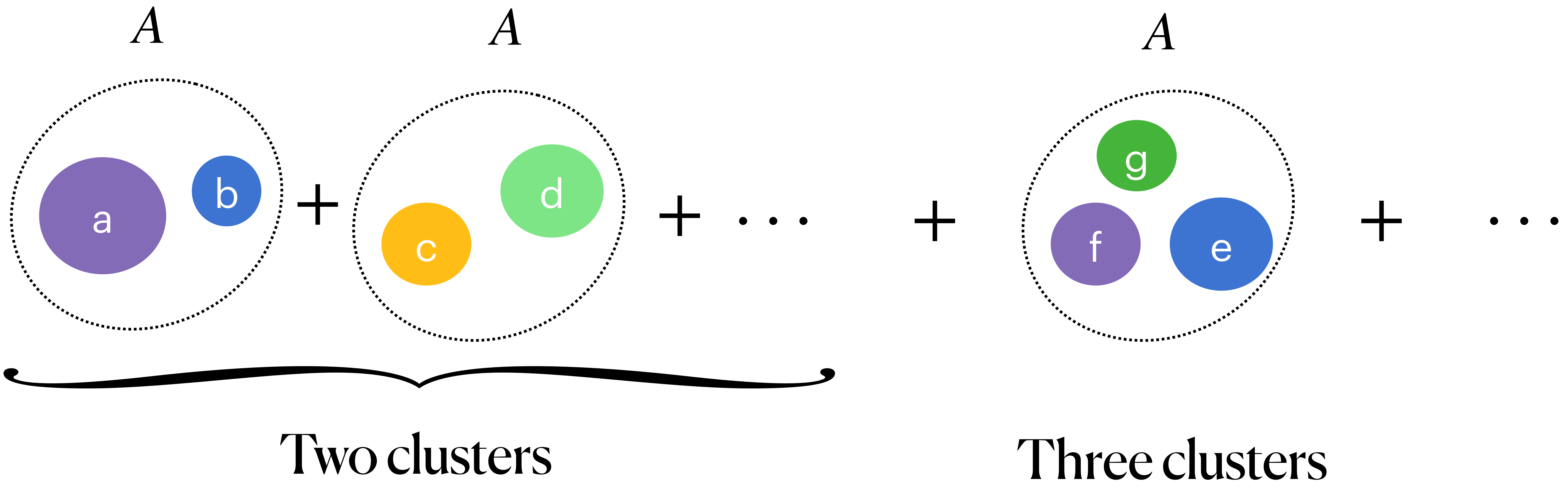
Group Meeting 10.31

Analysis of the $^{16}\mathrm{C}(d,p)^{17}\mathrm{C}$ reaction from microscopic $^{17}\mathrm{C}$ wave functions

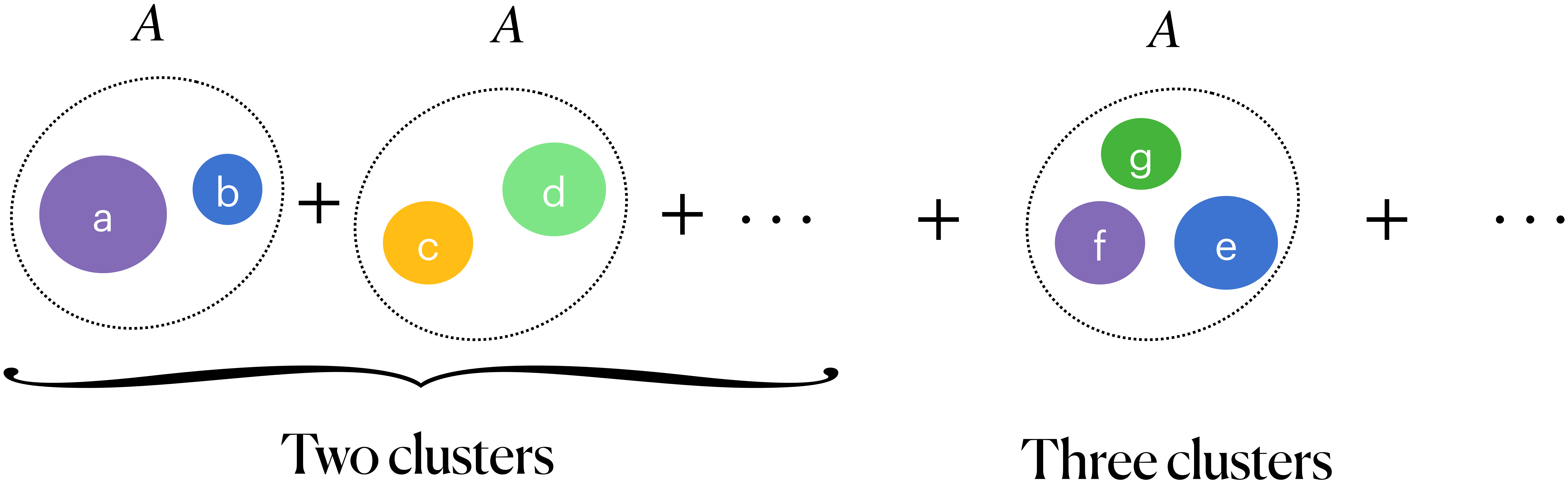
Hao Liu
Zetian Ma

Overview

The resonating group method (RGM) can give a microscopic description of the nuclei. When nuclei A can be described in the different cluster structures,



Overview



$$\psi = \mathscr{A}\Big(\sum_i \phi\left(\mathrm{A}_i\right)\phi\left(\mathrm{B}_i\right)F_i\left(\boldsymbol{R}_i\right)$$

$$+\sum_j \phi\left(\mathrm{A}_j\right)\phi\left(\mathrm{B}_j\right)\phi\left(\mathrm{C}_j\right)F_j\left(\boldsymbol{R}_{j1},\boldsymbol{R}_{j2}\right)+\ldots\ldots\Big)Z\left(\boldsymbol{R}_{\mathrm{cm}}\right).$$

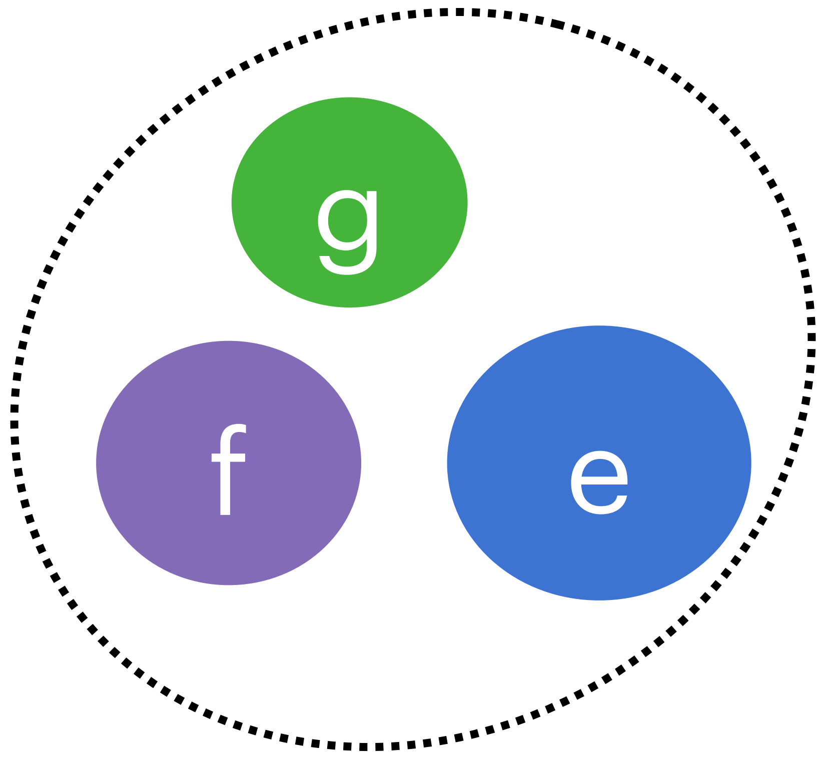
Overview

$$\psi = \mathscr{A}\Big(\sum_i \phi\left(\mathrm{A}_i\right)\phi\left(\mathrm{B}_i\right)F_i\left(\boldsymbol{R}_i\right) + \sum_j \phi\left(\mathrm{A}_j\right)\phi\left(\mathrm{B}_j\right)\phi\left(\mathrm{C}_j\right)F_j\left(\boldsymbol{R}_{j1},\boldsymbol{R}_{j2}\right) + \ldots\ldots\Big)Z\left(\boldsymbol{R}_{\mathrm{cm}}\right).$$

The wave function of the relative motion

The A-nucleon antisymmetrizor : $\mathscr{A}$

The nomarlization function : $Z(R_{\mathrm{cm}})$



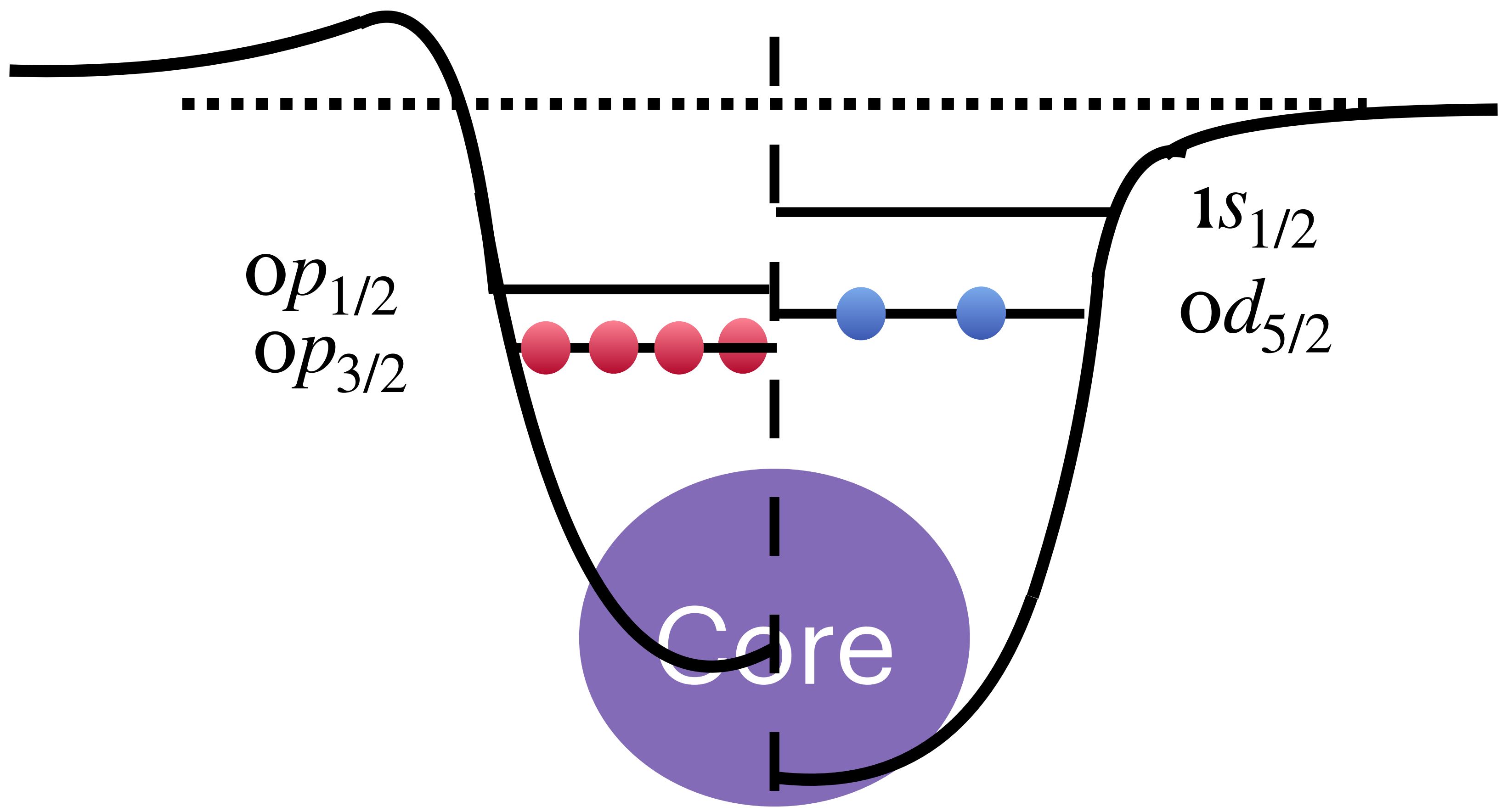
Method

They gave a microscopic description for the ^{17}C, which contained the excited states of the ^{16}C.

$$\Psi_{17}^{JM\pi} = \mathscr{A}\frac{1}{\rho}\sum_{c}\varphi_c^{JM\pi} g_c^{J\pi}(\rho)$$

where $$\varphi_c^{JM\pi} = \left[\left[\phi_{16}^{I_1} \otimes \phi_n\right]^I \otimes Y_\ell\left(\Omega_\rho\right)\right]^{JM}$$

The wave function of ^{16}C ground state and exited states are given by the shell model.



Method

The relative motion part can be expended by GCM as

$$g_c^{J\pi}(\rho) = \int dR\, f_c^{J\pi}(R)\Gamma_\ell(\rho, R)$$

$$\Gamma_\ell(\rho, R) = \left(\frac{\mu}{\pi b^2}\right)^{3/4} \exp\left(-\frac{\mu}{2b^2}\left(\rho^2 + R^2\right)\right) i_\ell\left(\frac{\mu\rho R}{b^2}\right)$$

In the GCM, the calculation of the radial functions $g_c^{J\pi}(\rho)$, is therefore replaced by the calculation of the generator functions $f_c^{J\pi}(R)$.

Method

The relative motion part can be expended by GCM as

$$g_c^{J\pi}(\rho) = \int dR\, f_c^{J\pi}(R)\Gamma_\ell(\rho, R)$$

spherical Hankel function

$$\Gamma_\ell(\rho, R) = \left(\frac{\mu}{\pi b^2}\right)^{3/4} \exp\left(-\frac{\mu}{2b^2}\left(\rho^2 + R^2\right)\right) i_\ell\left(\frac{\mu\rho R}{b^2}\right)$$

The idea underlying the GCM is to expand the radial function $g_c^{J\pi}(\rho)$, over Gaussian functions, centered at different locations, called the generator coordinates, $f_c^{J\pi}(R)$.