## $^{12}C(^{13}C,^{13}C),(^{13}C,X)$ 2016Ka37

History

| Type | Author | Citation | Literature Cutoff Date |
|---|---|---|---|
| Full Evaluation | J. H. Kelley, C. G. Sheu and J. E. Purcell | NDS 198,1 (2024) | 1-Aug-2024 |

1977Gu07: $^{12}C(^{13}C,^{13}C)$ E=12 MeV; measured $\sigma(\theta)$ for $\theta$=39° to 136° at Heidelberg Tandem accelerator. DWBA analysis. Deduced a model-independent value of $C^2$=2.55 *10* for the asymptotic normalization of the $1p_{1/2}$ neutron wave function. Using this, and a bound-state wave function obtained from analysis of electron elastic scattering, the absolute spectroscopic factor S=0.81 *4* was deduced.

1985Bo39: $^{12}C(^{13}C,^{13}C),(^{13}C,^{13}C')$ E=240 MeV; measured $\sigma(\theta)$ for $\theta_{c.m.}\leq$60° using the VICKSI spectrometer in Berlin; analyzed refractive scattering and nuclear rainbow effects for $^{13}C^*$(0, 3.85 MeV).

1986Ba80: $^{12}C(^{13}C,^{13}C),(^{13}C,^{13}C')$ E≈50 MeV; measured $\sigma(\theta)$ for $\theta$=20° to 160°. Deduced reaction mechanism.

1991Fu10: $C(^{13}C,X)$ E≈33 MeV/nucleon; measured total reaction cross section.

2000Fa12, 2000Fa17: $C(^{13}C,X)$ E≈33.4 MeV/nucleon; measured total reaction cross section.

2001Oz03: $C(^{13}C,^{13}C)$ E≈960 MeV; measured interaction cross section. Deduced matter radius of 2.28 fm *4*. See also (2001Oz04).

2010Al10: $^{13}C(^{12}C,^{13}C)$ E=10.6 MeV/nucleon; $\sigma$ and $\sigma(\theta)$ for $\theta_{c.m.}\leq$60° using the Texas A&M MDM spectrometer; deduced optical model parameters and asymptotic normalization coefficients (ANC) $C^2_{p1/2}$=2.24 $fm^{-1}$ *11*. They average their value with those from other reactions to obtain $C^2_{p1/2}$=2.31 $fm^{-1}$ *8*; with this value they analyze stellar reaction rates.

2016Ka37: XUNDL dataset compiled by TUNL, 2017.

The authors carried out a systematic study of the charge changing cross sections of ≈900 MeV/nucleon carbon isotopes on a carbon target and analyzed the data to obtain the proton and matter radii of $^{12-19}C$.

A beam of 828 MeV/nucleon $^{13}C$ ions was produced by fragmenting either a 1 GeV/nucleon $^{20}Ne$ beam or 1 GeV/nucleon $^{40}Ar$ beam on a thick beryllium target at the GSI/FRS facility. After magnetic separation, the $^{13}C$ beam particles were identified event-by-event using a multi-sampling ionization chamber and the time-of-flight between two scintillators. The beam then passed through a thick carbon target before being reanalyzed in a second multi-sampling ionization chamber that measured the Z of ions after the target. In the analysis, the ratio of the charge changing events to the non-charge changing events was determined and used to obtain $\sigma_\alpha$, the charge changing cross section. For $^{13}C$, $\sigma_\alpha$=726 mb *7* was determined.

The data were then compared with a finite-range Glauber model to obtain root-mean-square radii for the proton distribution and for the matter distribution. The results from the systematic study across $^{12-19}C$ is then compared with various models and comments are given on the development of neutron skins and neutron halos.

*Theory*:

1973Vo04: $^{12}C(^{13}C,^{13}C)$; calculated $\sigma(\theta)$, particle, hole transfer.

1975De09: $^{13}C(^{12}C,^{12}C)$, $^{13}C(^{12}C,^{12}C)$, $^{13}C(^{14}C,^{14}C)$ E=7.8-12.6 MeV; analyzed data and deduced optical model parameters.

1984Vo11: $^{12}C(^{13}C,^{13}C)$ $E_{c.m.}$=5-20 MeV; calculated $\sigma(\theta)$ vs E. $^{12}C(^{13}C,^{13}C')$ $E_{c.m.}$=7.8,9.88 MeV; calculated $\sigma(\theta)$, P($\theta$), $\sigma$. Coupled reaction channels model, valence nucleon molecular orbiting.

2019Ay05: $^{12}C(^{13}C,^{13}C)$ E<300 MeV; analyzed available $\sigma$ data; deduced the real part of the optical potential using the double folding model.

2021Do04: $^{12}C(^{13}C,^{13}C)$ E=7.8, 14.2 MeV; used CDCC model to calclate exchange effects in scattering reactions.

2023Ma02: $^{12}C(^{13}C,^{13}C)$; analyzed mass asymmetry and charge asymmetry effects in elastic scattering of light nuclei.

2022Ay05: $^{12,14}C(^{13}C,^{13}C)$; optical model analysis of elastic scattering of carbon isotopes, analyzed results from different NN interactions.

### $^{13}C$ Levels

| E(level) | $J^\pi$ | S | Comments |
|---|---|---|---|
| 0 | $1/2^-$ | 0.81 *4* | S: From (1977Gu07).<br>$R^{protons}_{r.m.s.}$=2.30 fm *4*, $R^{matter}_{r.m.s.}$=2.28 fm *4* (2016Ka37).<br>ANC is $C^2_{p1/2}$=2.24 $fm^{-1}$ *11* (2010Al10). |
| $3.85\times10^3$ | $5/2^-$ | | E(level): See discussion in (1985Bo39). |