Calculation of the ¹² C + ¹² C sub-barrier fusion cross section in an imaginary-time-dependent mean field theory

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INTRODUCTION&MOTIVATION

Letter 688 Nature | VOL557 | 31MAY2018

An increase in the ${}^{12}C + {}^{12}C$ fusion rate from resonances at astrophysical energies

A. Tumino^{1,2*}, C. Spitaleri^{2,3}, M. La Cognata², S. Cherubini^{2,3}, G. L. Guardo^{2,4}, M. Gulino^{1,2}, S. Hayakawa^{2,5}, I. Indelicato², L. Lamia^{2,3}, H. Petrascu⁴, r. G. Pizzone², S. M. r. Puglia², G. G. rapisarda², S. romano^{2,3}, M. L. Sergi², r. Spartá² & L. Trache⁴







Status on ${}^{12}C + {}^{12}C$ fusion at deep subbarrier energies: impact of resonances on astrophysical S^* factors

C. Beck^{1,a}, A. M. Mukhamedzhanov^{2,b}, X. Tang^{3,4,c}

Eur. Phys. J. A (2020) 56:87

$$S^{*}(E_{c.m.}) = E_{c.m.}\sigma(E_{c.m.})\exp(87.12E_{c.m.}^{-1/2} + 0.46E_{c.m.})$$

$$= S(E_{c.m.})\exp(0.46E_{c.m.})$$
(1)



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Feynman path integration in phase space

Physics Letters B 339 (1994) 207-210

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Solve the Vlasov equation in imaginary time. Define collective variables R&P





NEWTONIAN DYNAMICS OF TIME-DEPENDENT MEAN FIELD THEORY

Phys.Lett.B141(1984)9; 168B(1986)35.

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Neck model in imaginary times <u>PHYSICAL REVIEW C 102, 061602(R) (2020</u> The probability of fusion for the *l* th-partial wave is given by $T/=1/(1 + \exp\{2A\})$, $A = \int_1^2 P \ dR$



To take into account resonances modify the Bass potential as:

$$V_{\rm B} \rightarrow V_{\rm B}[1 + g(x, \gamma, \sigma)],$$

Analytical formula

 $S_0 = S_G e^{\frac{4\sqrt{2\mu Z_1 Z_2 e^2 R_N}}{\hbar}}.$ $S_G = \pi \hbar^2 / (2\mu)$

S. Kimura and A. Bonasera, Phys. Rev. C 76, 031602(R) (2007).

Last but not least, S and S^{*}- what if we use the action A instead?



(2007).

Conclusions

The Neck model and the Vlasov approach in imaginary time give S*>e16MeVb for Ecm>0.5 MeV (agrees with analytical formula as well)

Adding resonances is in some agreement with the THM

I=0 channel is dominant up to Ecm=3MeV

if the properties of the resonances (spin, width etc..) are confirmed then:

THANKS



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