

## Non-statistical structures in $^{12}\text{C}(^{15}\text{N}, ^4\text{He})^{23}\text{Na}$ reaction

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**Abstract.** The data on the  $\theta_{\text{lab}} = 7^\circ$  excitation functions of  $^{12}\text{C}(^{15}\text{N}, ^4\text{He})^{23}\text{Na}$  reaction between  $E_{\text{cm}} = 9.42$  and  $17.33$  MeV for 28 states upto an excitation energy of  $8.940$  MeV in  $^{23}\text{Na}$  have been subjected to statistical analysis. In addition to statistical fluctuations, the results of the analysis indicate the existence of non-statistical structures at  $E_{\text{cm}} = 10.66, 10.93, 11.38, 12.62, 13.16, 15.32$  and  $16.18$  MeV.

**Keywords.** Statistical analysis; Hauser-Feshbach cross-sections; probability distributions; deviation function; correlation function; coherence widths.

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### 1. Introduction

Pronounced resonant effects have been observed in many light heavy-ion reactions involving  $\alpha$ -conjugate nuclei (see papers in Cindro 1978, 1981, for example). The resonant effects are particularly marked for  $^{12}\text{C} + ^{12}\text{C}$  (Macgregor *et al* 1968; Cosman *et al* 1973; Van Bibber *et al* 1974; Voit *et al* 1974),  $^{12}\text{C} + ^{16}\text{O}$  (Macgregor *et al* 1969; Viggars *et al* 1976; Brady *et al* 1977) and  $^{16}\text{O} + ^{16}\text{O}$  (Siemssen *et al* 1967; Maher *et al* 1969; Shaw Jr *et al* 1969; Gay *et al* 1986) systems. The scattering and reactions involving combinations of non- $\alpha$ -conjugate even-even nuclei such as  $^{14}\text{C} + ^{14}\text{C}$  (Konnerth *et al* 1980; Drake *et al* 1981), and other even-even nuclei like  $^{14}\text{C} + ^{12}\text{C}$  (Freeman *et al* 1980, 1981; Konnerth *et al* 1985) and  $^{14}\text{C} + ^{16}\text{O}$  (Bernhardt *et al* 1978; Kolata *et al* 1981) have also exhibited pronounced resonant and other non-statistical effects. In addition, the collisions involving combinations of non- $\alpha$ -conjugate (at least one partner) nuclei like  $^{12}\text{C} + ^9\text{Be}$  (Mateja *et al* 1978; Dennis *et al* 1981),  $^{12}\text{C} + ^{11}\text{B}$  (Frawly *et al* 1979),  $^{10}\text{B} + ^{14}\text{N}$  (Ecuyer *et al* 1975; Marquardt *et al* 1977),  $^{12}\text{C} + ^{13}\text{C}$  (Crozier and Legg 1974; Cordell *et al* 1979),  $^{12}\text{C} + ^{14}\text{N}$  (Cordell *et al* 1978; Dennis and Thornton 1980), and  $^{12}\text{C} + ^{15}\text{N}$  (Gomez del Campo *et al* 1977; Ortiz *et al* 1980) lead to scattering and/or reactions that also show resonant and correlated structures. Gomez del Campo *et al* (1977) reported 16 resonances in  $^{12}\text{C}(^{15}\text{N}, ^4\text{He})^{23}\text{Na}$  reaction over the energy range from  $E_{\text{cm}} = 9.5$  to  $17.3$  MeV, which were interpreted to be arising from the strong population of non-overlapping states near the yrast line in  $^{27}\text{Al}$  compound nucleus. Further analyses of these data confirmed the existence of non-statistical structures at  $10.1$  and  $15.4$  MeV (Thornton 1980) and at  $11.47, 12.4, 15.4$  and  $16.2$  MeV (Dennis *et al* 1979). According to the most recent analysis (Ortiz *et al* 1980) of the  $^{12}\text{C}(^{15}\text{N}, ^4\text{He})^{23}\text{Na}$  excitation functions at  $\theta_{\text{lab}} = 7^\circ$  there are large anomalies which are not compatible with the statistical model predictions. It was noted by these authors