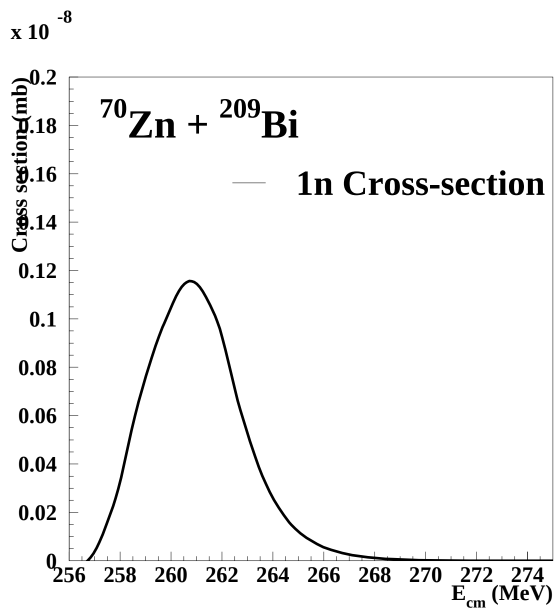
Theoretical predictions of cross-sections of the super-heavy elements

B. Bouriquet[1] G. Kosenko[2] and Y. Abe [1]

Yukawa Institute for Theoretical Physics, Kyoto University, Kitashirakawa-Oiwake-Cho Sakyo-ku, Kyoto 606-8502 [1]
Department of Physics, University of Omsk, RU-644077 Omsk, Russia [2]

Since the discovery of the periodic table of the elements by Mendelejeff [1] in 1869, many element have been identified and analysed. However, some superheavy elements (SHE) remain undiscovered even if their existence is theoretically predicted by many studies. The most difficult and less studied point in the synthesis of SHE is the fusion mechanism that leads to their formation. The difficulty comes mainly from the effect of the so call "fusion hindrance" that reduces the fusion probability when very heavy ions are involved in the reaction. To modelise the reaction process we assume the compound nucleus theory is applicable to such a nucleus. Thus, the cross section can be written as $\sigma_{res} = \pi \bar{\lambda}^2 \sum (2J+1) P^J_{fusion}(E_{c.m.}).P^J_{surv}(E^*)$. In this equation we have to evaluate P^J_{fusion} and P^J_{surv}. The first part can be given as the product of the sticking P^J_{stick} and formation probability $P^J_{formation}$, according to the two-step model for fusion of massive systems which takes into account the hindrance [2, 3]. P^J_{stick} and $P^J_{formation}$ can be calculated by solving the stochastic equation of Gross-Kalinowski [4] and of shape evolution [5], respectively. The P^J_{surv} is calculated with the disintegration code KEWPIE [6] that is specially dedicated to the super-heavy elements.



This method that has been applied successfully to the hot fusion path [2] has been extended to the cold fusion path. The results of those calculations reproduce remarkably well the $1n$ cross-sections for the reactions leading to the production of $Z = 110$, $Z = 111$, and $Z = 112$. This excellent quality of the agreement permits to generalise it so as to predict $1n$ cross-sections for elements $Z = 113$ and $Z = 114$ [7]. An example for Z=113 is shown in the figure.

[1] D. Mendelejeff, *Chemie*, **12** 405 (1869).
[2] C.W. Shen et al., *Phys. Rev. C66* 061602(R) (2002).
[3] Y. Abe et al., *Prog. Theor. Phys. Suppl.* 146, 104 (2002).
[4] D.H.E. Gross and H. Kalinowski, *Phys. Rept.* **45**, 175 (1978).
[5] Y. Abe et al., *Phys. Rept.* **275**, Nos. 2 and 3 (1996); Y. Abe *J. Phys.* **G 23**, 1295 (1997); Y. Aritomo *et al.*, *Phys. Rev.* **C59**, 796 (1994)
[6] B. Bouriquet et al., Submited to *Comp. Phys. Com.*
[7] B. Bouriquet et al., Submited to *Phys. Rev. Let.*