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Unraveling the reaction rate conventions for use in the k0 standardization of NAA

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The majority of developers and users of the NAA k0 standardization do not realize that this method was launched [1] in terms of the accurate and generally applicable Stoughton-Halperin convention [2] for the description of the (n,γ) reaction rate. Later on, in the article reporting on the first k0-measurements [3], the more practical Høgdahl convention [4] was introduced instead (as had been done in earlier work on k-factors [5]), which was modified to account for a non-ideal (assumed 1/E1+α) epithermal neutron flux distribution thereby introducing Ryves'concept of the effective resonance energy [6]. This resulted in a user-friendly protocol, which however ruled out some five (n,γ) reactions with a significant deviation from the ideal 1/v cross section dependence in the thermal neutron energy region. Although in the course of the years it was argued [7] that only a few excluded cases did not justify the changeover from a simple convention like Høgdahl's to a more sophisticated one, finally the rigorously accurate Westcott convention [8] –with introduction of the α epithermal shape factor - was put forward to incorporate the non-1/v cases in the k0 standardization methodology [9]. Obviously, this turned out to be too complex and impractical for a good deal of the k0-NAA community, notably in the context of the Kayzero software [10] where use is made of an intermediate comparator factor defined in terms of the Høgdahl convention. Therefore, recently the "extended Høgdahl convention"[11] was launched, which takes into account the non-1/v cross section behavior by rather randomly inserting Westcott's g(Tn) factor in the Høgdahl expression, where Tn is the maxwellian neutron temperature. Although the proof of validity of this extension was based on empirical and hardly on scientific arguments, it can nevertheless be regarded as a valid approach –as shown in the present paper where it is derived from the Stoughton-Halperin convention by introducing a few justifiable approximations. Hence, it can be smoothly implemented in the Kayzero software and in other concentration calculation programs while yielding for the 1/v and non-1/v (n,γ) reactions concentration results which are accurate to acceptable, respectively. This is a promising development in the context of the general applicability of the NAA k0 standardization.

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