Program Advisory Committee for Nuclear Physics
51st Meeting, 30−31January 2020

Referee Report by Sigurd Hofmann
to the Proposal by Alexander Eremin
on the “Prospects for Study of Multinucleon Transfer Reactions”

Indeed, the study of multinucleon-transfer reactions has emerged as a promising tool for studying nuclei that cannot be produced in heavy-ion fusion reactions, fragmentation reactions or, like in the case of fusion reactions with radioactive beam ions, the intensities may be too small for a sufficient production.

In the past, nuclear chemists favoured multinucleon-transfer for production of spherical superheavy nuclei (SHN) in reactions like 238U + 238U or 238U + 248Cm. The theoretical background was that the flow of nucleons from the beam to the target will be into the direction of SHN having a locally increased stability. However, first experiments investigating the reaction products by chemical means revealed a rapid decrease of the cross-section with increasing element number. The heaviest nuclei identified in these reactions were from mendelevium (A = 255 to 258) with cross-sections of 60 nb, see e.g. M. Schädel et al., Phys. Rev. Lett. 48, 852 (1982).

More recent theoretical studies by V. Zagrebaev and W. Greiner, Nucl. Phys. A 944, 257 (2015) obtained a nucleon flow such that nuclei near 208Pb are produced as one of the primary products in reactions like 238U + 248Cm. The second primary fragments will then be nuclei near 278Sg. Therefore, this type of reaction is considered promising for synthesis of neutron rich isotopes of elements near seaborgium. Multinucleon transfer may also open a possibility to come closer to the region of nuclei with longest lifetimes expected at 288Hs – 292Ds.

However, these heavy nuclei will be excited having a high probability for fission. Therefore, multinucleon transfer reactions are not considered as an option for producing new elements above the known element oganesson, $Z = 118$.

It is certainly an ambitious but also an exciting aim to produce SHN with longest lifetimes near 288Hs – 292Ds. Before such an enterprise can start it is necessary to receive information on the optimum choice of beam and target isotopes and beam energy. The most appropriate separator has to be selected. Additional devises behind the separator like multi-reflection time-of-flight spectrometers (MRTOF) have to be installed in order to overcome the difficulties of the correlation method at long lifetimes of the produced nuclei. This equipment will then be sensitive to detect not only α decaying or fissioning nuclei but also nuclei on the neutron rich side of the valley of stability, which are expected to undergo β^- decay.

A detailed study of multinucleon transfer reactions as proposed by A. Yeremin and co-workers has in my opinion a broad and promising perspective. I fully support this proposal and would like to ask the FLNR and JINR directorate for sufficient manpower and financial support for this project.

Sigurd Hofmann,
GSI Darmstadt, January 14, 2020