

QUASIELASTIC NUCLEON TRANSFER BETWEEN HEAVY NUCLEI AND THE
NUCLEAR JOSEPHSON EFFECT

W. von Oertzen

Hahn-Meitner-Institut, Berlin and Fachbereich Physik,
Freie Universität Berlin

Due to recent advances in experimental techniques the question of pairing effects in pair-transfer reactions between very heavy nuclei and their relation to a Josephson effect gains a strong actuality. Since almost 20 years different authors have discussed the structural and dynamical aspects of such an effect. A variety of experiments on quasielastic transfer between heavy nuclei at energies close and below the Coulomb-barrier have been performed in the last 5 years. From this work, one can deduce the probabilities for the transfer of a nucleon and of nucleon pairs. The enhancement, which is observed in pair transfer (two neutrons or two protons) can be related to the configuration mixing in heavy nuclei due to the pairing interaction. This pairing interaction is strongest at low excitation energy and for 0^+ states. Data for pair transfer between heavy nuclei, however, have so far not been obtained with a resolution necessary to separate individual states. Nevertheless it is possible to give a quantitative discussion of the pair transfer probability for a variety of cases (in particular neutron-pair transfer in $^{112}\text{Sn} + ^{120}\text{Sn}$, proton-pair transfer in $^{88}\text{Sr} + ^{144}\text{Sm}$). The enhancement of the pair transfer is well observed in the two cases, for the proton pair transfer it persists even for two-pair transfer indicating the macroscopic properties of the pair wave functions and suggesting a supercurrent between the two nuclei. An important aspect is the damping of the flux due to inelastic transitions, in which pairs are broken and which lead to channels different from the pair transfer channels. Strong coupling situations, which could be easily achieved at higher incident energies above the barrier, will simultaneously be cases of very strong damping (absorption) and the observation of multiple transfer does not seem to be the adequate phenomenon to observe the Josephson effect.

For the case of proton pair transfer, where tunnelling does actually occur through a barrier between two potential wells effects due to properties of a macroscopic wave-function could be anticipated, due to the long range Coulomb interaction. Systematic studies of proton pair transfer, with varying potential levels (binding energy differences due to Coulomb effects) between heavy nuclei give prospects for a further study of this physically interesting possibility.