pairs. Specifically, in terms of two–nucleon transfer reactions. Being even more *subjective* (concrete), we were interested in shedding light on the structure of one of the 5-6 Cooper pairs participating in the condensate (intrinsic state in gauge space) of the Sn–isotopes (ground state rotational band[38]) through pair transfer processes. That is $^{A+2}\mathrm{Sn}(p,t)^{A}\mathrm{Sn(gs)}$ processes in general, and $^{120}\mathrm{Sn}(p,t)^{118}\mathrm{Sn}$ in particular. From a strict observational perspective, concerning Cooper pairs, one can only refer to the information two–nucleon transfer absolute differential cross sections carry on these entities. On the other hand, leaving the discussion regarding the microscopic calculation of the optical potential, the carriers mediating information between structure and differential cross sections, e.g. between target and outgoing particle in a standard laboratory setup, are the distorted waves. These functions can be studied independently of the transfer processes under consideration, in elastic scattering experiments. Consequently, the non–local, correlated formfactors,

$$F(\mathbf{r}_1, \mathbf{r}_2, \mathbf{r}_{Ap}) = F_{succ} + F_{sim} + F_{NO}, \tag{6.5.1}$$

sum of the successive and simultaneous transfer processes and of the non–orthogonality correction, calculated with different stes of two–nucleon spectroscopic amplitudes can be compared at profit to each other. This is in keeping with the fact that they can be related, in an homogeneous fashion, with the absolute cross sections or, better, with the square root of these quantities.

6.5.6 Closing the circle[39]

In the first reference of this monograph[40] entitled "Quantum mechanics of collision phenomena", Born considers the elastic scattering of a beam consisting of N electrons which cross unit area per unit time, scattered by a static potential. The stationary wavefunction describing the scattering process behaves asymptotically as,

$$e^{ikz} + f(\theta,\phi)\frac{e^{kr}}{r}, \qquad \left(k = \frac{mv}{\hbar}\right). \tag{6.5.2}$$

The number of particles scattered into the solid angle $d\Omega = \sin\theta d\theta$ is given by $N|f(\theta,\phi)|^2 d\Omega$. To connect with Born notation one has to replace $f(\theta,\phi)$ by Φ_{mn}, where n denotes the initial–state plane wave in the z–direction and m the asymptotic final–state in which the waves move in the direction fixed by the angles (θ,ϕ). Then Born writes that Φ_{mn} determines the probability for the scattering of the electron from the z– to the $(\theta\phi)$–direction, adding a footnote in proof, as already mentioned, stating that a more precise consideration shows that the probability is proportional to the square of Φ_{mn}. In a second paper with the same title of the first[41] he states ex-

and ω-dependen

It is also of notice, that the dimension, structure and non-locality of the function (6.5.1) is expected to be rather different from that of the structure wavefunction of the Cooper pair, a question closely connected with linear response, While this concepta

(see discussion following Eq. (6.4.16))

@-@

pp 1-4

[38] Potel, G. et al. (2013b); Potel et al. (2017)

[39] In this section we follow closely Pais (1986)

[40] Born (1926a).

[41] Born (1926b)

København 11/09/17 1

~~reaction~~ to p. 439

~~While the concept of linear response~~

(a) has been and continues to be quite useful in the study of many-body systems, ~~it may lead to not correct conclusion~~ ~~it is quite a subtle one~~ it is a subtle one.

In direct two-nucleon transfer reactions induced by both light and heavy ~~reactions~~ ion grazing collisions, the ~~interaction~~ contact between the two interacting nuclei is weak. Nonetheless, even a very low density overlap between target and projectile may induce important ~~chang~~ modifications in Cooper pairs. Most importantly, allow nucleon partners to profit from the enlarged volume as compared to that available in the target nucleus to expand, recede from each other and, in the process, lower the relative kinetic energy of confinement. As a consequence, one-nucleon can be transferred at a time, successive ~~expanding~~ being the dominant transfer mechanism.

This is the reason why Cooper pair transfer displays absolute cross sections of the same order of magnitud of one-nucleon transfer processes.

It can be stated that this picture is again ~~a result~~ an example of the ~~validity~~ fruitfulness of linear response to shed light on subtle questions regarding many-body systems. In the case under discussion, it allows the partners of the nuclear Cooper pair to correlate over dimensions larger than nuclear dimensions and in so doing make their intrinsic structure observable, almost free of the strong presures of the external mean field*! The above discussion is illustrated in Fig. 6.5.5.

With it one comes back to the original question (Sect. 1.1). Which are the proper variables to be used in an attemp of describing the nuclear system? Elementary modes of excitation is a valid choice.

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*) Within this context, think of the need of both right and left superconductors with respect to the dioxide layer to be able to measure gauge phase difference in the Josephson effect.

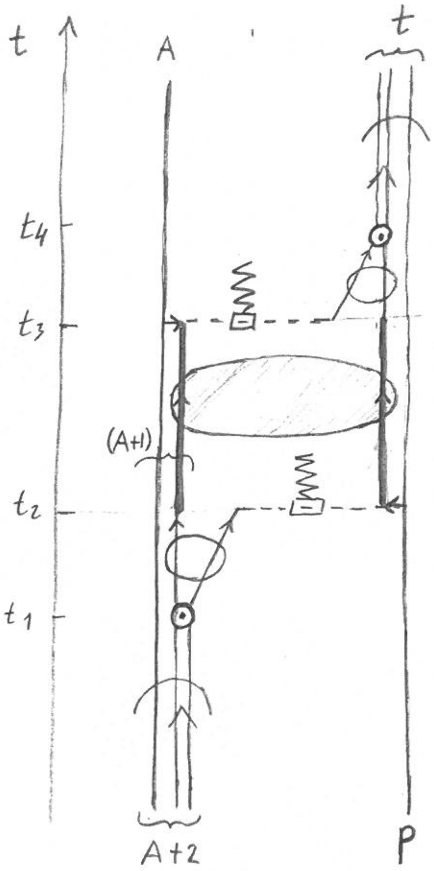
København 11/09/1

But because these modes are in interaction, (3)
the above choice is not sufficient (unique).
An operative definition requires ~~that~~ also ~~the~~
specific probe, reaction or decay process
is specified. In fact, if one were to study
Cooper pairs through election scattering
(two-nucleon correlations), one would
obtain a picture of the system as
that marked by the small ellipses
in Fig. 6.5.5. Thus, rather different from
the one which emerges from the
(p,t) process (large ellipse, correlation
length ξ).

ⓐ-ⓐ
p. 439

$R_d =$

$R_t =$



in the interval: $\Delta t = t_3 - t_1$,

In other words, this is the observable Cooper pair in terms of its specific probe, and the reason why the neutrons are described in terms of bold face arrowed lines.

Fig. 6.5.5

Diagram describing structure and reaction aspects
of the main process through which a Cooper pair
(di-neutron) tunnels from target to projectile
in the reaction $(A+2)+p \rightarrow A+t$. In order that the
two-step process $(A+2)+p \rightarrow (A+1)+d \rightarrow A+t$ takes
places, target and projectile have to be in con
tact at least in the time interval running between
t_2 and t_3. During this time, the two systems create,
with local regions of ever so low nucleonic presence, a common
density over which the non-local pairing field can be
established, and the Cooper pair correlated. Even
with region in which the pairing interaction may
be zero. Small ellipses indicate situations in which
the two neutron correlation is distorted by the external
mean field. The large ellipse indicated the region in
which the two partners of the Cooper pair correlate over
distances of the order of the correlation length ξ. Is this
information that the outgoing particle brings to the detector.