EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN-EP/82-91
29 June 1982

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Presented at the
Workshop on Physics at LEAR
With Low-Energy Cooled Antiprotons
Erice, Sicily, 9-16 May 1982

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The prospect of starting a new generation of experiments with $\bar{p}$ at LEAR stimulates interest in studies of $\bar{p}$ interactions with nuclei. A rather intriguing question arises here: Is the real part of the $\bar{p}$A potential much larger than for pA interactions? (and does it make sense to talk in terms of a $\bar{p}$A potential in view of the very strong annihilation?). If the answer is Yes, then one can expect that a $\bar{p}$ is strongly accelerated at the nuclear surface before it annihilates on a single nucleon, and as a result of momentum conservation the residual nucleus (A-1) formed at $\bar{p}$ annihilation might have an anomalously high velocity. Of course one has to bear in mind that final-state interaction (fsi) of $\bar{p}$ annihilation debris (π,K) will normally affect the energy spectra of recoiling nuclei. What we want to speak about in this paper is how to "filter" out experimentally events where a residual nucleus has *not* undergone fsi with annihilation debris. A good candidate for this is ^{8}Be.

It is well known, for example from (pd) reactions[1], that ^{9}Be consists of about 2.5% of a ^{8}Be (gs) core with a single, weakly bound neutron. Annihilation of $\bar{p}$ (stopped in ^{9}Be) on this neutron can leave us with an intact ^{8}Be (gs). The chance for this may be small, say 10^{-3}, corresponding to the cases where annihilation products escape in a plane tangential to the nuclear surface. With such a survival rate of ^{8}Be we might expect $\sim 2.5 \times 10^{-2} \times 10^{-3} \simeq$ $\simeq 2.5 \times 10^{-5}$ Be (gs) events per $\bar{p}$ stop. Owing to momentum conservation, the recoiling residual ^{8}Be nucleus will have $\sim$ 1/9 of the kinetic energy which the $\bar{p}$ gained in the nuclear surface just before annihilation. Ultimately this energy gain could be up to $\sim$ 65 MeV (!) if we adopt $V_0 \sim 600$ MeV. The chance that ^{8}Be (gs) has gained such a large energy by fsi with annihilation products is probably small, since ^{8}Be is already an unstable nucleus which decays into 2α with 94 keV Q value and a lifetime of $\sim 10^{-16}$ s. A hard kick would probably separate the soft ^{8}Be. If this fsi *does* produce two α's, they are then corresponding to large excitations in the ^{8}Be continuum. So the trick is to reconstruct the ^{8}Be invariant mass and the ^{8}Be recoil energy at the same time from an angular and energy (time of flight) measurement of the two decay α particles. In the sub-sample with ^{8}Be (gs) mass, there (and only there) one might find the anomalously high recoil energies which point to a large V_0.

The ^{8}Be (gs) sample has a very specific and rather clean signature which can already be easily explored, namely the appearance of a maximal angle between the decay α particles. This angle is of the order of the small c.m. decay momentum ($\sim$ 19 MeV/c) divided by half the ^{8}Be (gs) momentum and is shown in Table 1 for different kinetic ^{8}Be (gs) energies; fsi has the tendency to increase these angles. The appearance of two α of similar energy under small angles in the sample of αα events would already be an indication of ^{8}Be (gs) production, and the α energies would tell us something about the strength of the $\bar{p}$A potential.

Another fascinating and completely different signature for ^{8}Be (gs) recoil might be the existence of channelling effects of the decay α in a thin crystalline ^{9}Be target. (For channelling effects at LEAR, see Uggerhøj[2]). There is a delayed decay

^{8}Be (gs) $\rightarrow \alpha + \alpha$ (Q = 9 keV),
with a lifetime of $\tau \simeq 6 \times 10^{-16}$ s ($\Gamma \sim 6$ keV) .

Table 1. Relation between ^{8}Be (gs) momenta and kinematical properties of decay α particles from ^{8}Be (gs) $\rightarrow \alpha + \alpha$

Momentum of ^{8}Be (gs) (MeV/c)	Kinetic energy $T \simeq \frac{V_0}{9}$ of ^{8}Be (gs) (MeV)	"V_0" (MeV)	Maximum angle between α & ^{8}Be direction (degrees)	α momentum (MeV/c)	
				min	max
0	0	0	180	18.8	18.8
100	0.67	6	22.1	31.2	68.8
250	4.2	38	8.7	106	144
350	8.2	74	6.2	156	194
500	16.7	151	4.3	231	269
700	32.8	295	3.1	331	369
1000	66.7	601	2.16	481	519

The intrinsic lifetime allows for a migration over 5 to 25 lattice cells which gives a homogeneous "illumination" of the unit cell and can lead to channelling. Prompt α production in the annihilation process, however, will only give blocking patterns.

With 10^6 $\bar{p}$ stopped per second, $\sim 2.5\%$ $[{}^8\text{Be (gs)} + n]$ strength in ^{9}Be, and $\sim 10^{-3}$ survival of ^{8}Be (gs) we could illuminate the lattice with ~ 25 ^{8}Be decays per second. The ^{9}Be lattice can guide α particles with transverse momentum up to ~ 0.75 MeV/c. With the typical α momenta shown in Table 1 this corresponds to acceptable (Lindhard) angles of the order of 2 mrad up to 8 mrad. For a planar channelling, one of the low-order lattice planes can accept a fraction of ~ 2 to $\sim 8 \times 10^{-3}$ of the produced α from ground-state decays. This would give 0.05 to 0.2 per second! With these rates, of course, $\alpha\alpha$ experiments would also be possible with *channelling in coincidence*. The probability of finding planar channelling of two α's in coincidence is (geometrically) enhanced for decreasing angles between the two decay α particles.

The ^{8}Be (gs) serves as a probe of few 10^{-13} cm diameter in the interior of a unit cell of the lattice with typical dimensions of 2×10^{-8} cm. Two perfectly coincident α are emitted through the lattice structure. We want to stress that such coincidence experiments would open up a completely new and very exciting possibility of studying channelling and effects of the dynamics of lattice oscillations in solid-state physics.

In order to study $\bar{p}$ annihilation on ^{9}Be, one needs position-sensitive detectors which are selective for low-energy, highly ionizing α's. The equipment for a search of heavy hypernuclei[3] (experiment PS177) with position-sensitive parallel-plate chambers covering a large solid angle is adequate for this goal.

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