Why is it so hard to polarize Nuclear Spin of solid Hydrogen Isotopes?

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Simple considerations concerning the nuclear spin polarization methods, namely: the "Static Polarization" (Brute Force) and the "Nuclear Dynamic Polarization" (DNP), show that it will be very difficult to feed fusion reactors with sizeable quantities of polarized fuel in the solid phase.

The symmetry restrictions of the homo-molecules WF shorten the spin-lattice relaxation times, even as small impurities which survive long time as isomers. For hetero-molecules, relaxation times are limited solely by the homo-impurities. This has allowed the static polarization of pure *HD*, by which vector polarizations rates for *H* and *D*, respectively of 70 % and 40%, have been achieved [1]. Unfortunately, this method cannot be applied to *DT* molecules, because of the heat generated by the Tritium radioactivity. One has therefore to rely on the DNP.

Since *HD* and *DT* molecules have very similar magnetic properties, it is convenient to optimize the DNP protocol on *HD* before applying it to *DT*. So far, the results obtained by the DNP of *HD* were not encouraging. The maximum polarization rates of less than 5% [2] could have been limited by significant amounts of H_2 and D_2 impurities. Much purer *HD* samples are now available and could open a way towards the nuclear spin polarization of *DT* [3].

References

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