Progress in Polarized ^{3}He Ion Source at RCNP

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Over the decade, we have developed a polarized ^{3}He ion source for spin physics at intermediate and high energy regions. We started with an OPPIS-type polarized ^{3}He ion source encouraged by the pioneering success in the OPPIS polarized proton ion source[1]. However, it was, subsequently, found that an enormously strong decoupling field (~32 T) was required for creating the ^{3}He polarization against the depolarization due to the LS coupling in $^3He^+$ ion[2].

To overcome this difficulty we proposed an EPPIS (Electron Pumping Ion Source)[3] as an extended method of the OPPIS free from the large LS coupling, and experimentally proved validity of the EPPIS principle[4]. However, since the EPPIS requires a polarized alkali vapor density much higher than the OPPIS, this method was technically impractical.

In the course of the EPPIS development, an extremely large spin-exchange cross sections σ_{se} ($>10^{-14}$ cm^2) between a $^3He^+$ ion and Rb atom was suggested at a low $^3He^+$ incident energy (~1 keV/A) by the semiclassical close-coupling method based on the molecular orbital expansion[5]. If this is experimentally proven, it must be used for one of the most convenient polarized ^{3}He ion sources in future[6]. We named this source "SEPIS" (Spin Exchange Polarized Ion Source).

Current status is that we have almost completed construction of the device enabling the σ_{se} measurement at 1.0-19 keV. Besides, since the electron capture processes are also important phenomena in determining an output current of the polarized beam extracted from the SEPIS, we measured the electron capture cross sections σ_{ec} for the $^3He^+$ + Rb system and found that the observed energy dependence of σ_{ec} was qualitatively reproduced by the theory[5,7].

References

[1] Y. Mori et al., J. Phys. Soc. Jpn. 55 (1986) 453.
[2] M. Tanaka et al., Phys. Rev. **A50** (1994) 1184.
[3] M. Tanaka et al., Phys. Rev. **A52** (1995) 392.
[4] M. Tanaka et al., Phys. Rev. **A60** (1999) R3354.
[5] Y. Arimoto et al., Phys. Rev. **A64** (2001) 062714-1.
[6] M. Tanaka et al., Nucl. Instr. and Meth. A537 (2005) 501.
[7] M. Tanaka et al., Nucl. Instr. and Meth. A (2006) in reviewing.