R&D on ^{3}He nuclear polarization for neutron scattering

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Nuclear polarized ^{3}He gas is now commonly used for neutron scattering as neutron spin filters as well as neutron spin analyzers in the world leading neutron facilities. Either of the two optical pumping techniques, the metastability optical pumping - MEOP and the spin exchange optical pumping - SEOP, is used to obtain highly polarized ^{3}He gas. In the SEOP method, the spins of the unpaired electrons in alkali metal atoms are aligned by circularly polarized laser, and then the spin exchange between the unpaired electrons and ^{3}He nuclei accomplishes the ^{3}He nuclear polarization.

High power and narrow width lasers are the key to achieve high ^{3}He polarization. Laser diode arrays (LDA) with the output power of 100 Watts or higher are commercially available and commonly used in various fields today. However, these high power LDA have rather wider wavelength band compared to the absorption line width of the alkali metal atoms in the optical pumping. There have been several types of external cavities applied to high power LDA to narrow the emission band width [1].

There has been found an excess of the ^{3}He relaxation of which source is not yet understood but primarily responsible for the ^{3}He cell (container) surface [2]. Studies for this excess are underway in various means to overcome the limitation on the ^{3}He polarization.

Safety is an important issue in scientific research. The SEOP makes use of high power lasers and high temperature heaters that have to be operated continuously for days. Various safety measures have been taken, and several interlock switches have been developed to prevent unwanted accidents.

References

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