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High-brilliance and high-flux neutron cold source based on elongated rectangular moderators.

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It is known [1] that optimized low-dimensional liquid para-H2 moderators can deliver 2-3 times higher cold neutron brightness compared to volumetric para-H2 moderators.

We present a new analytic approach to calculate the brightness of liquid para-H2 moderators. It is shown that the brightness gain is the near-the-surface effect, so that narrow cold moderators shaped as elongated rectangular parallelepiped provide a substantially higher cold neutron brightness compared to the para-H2 moderator optimized for ESS [1]. The obtained results are in excellent agreement with MCNP calculations.

As the brightness gain of such narrow moderators is associated with a decrease in neutron beam intensity, the moderators'assembly with the well-developed total surface will provide wide intense neutron beams while maintaining the high brightness of the narrow moderator. This can achieved by the suggested staircase moderator geometry.

Inhomogeneous thermal neutron flux distribution around the reactor core or the target of a spallation source sets a limit to potential brightness gains. This can be partly overcome by the stacked staircase moderator geometry that allows for the brightness gain up to 2.5-3.5 relative to the single flat moderators of the same width.

[1] K. Batkov et al., Nuclear Instr. Meth. A 729 (2013) 500.

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