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Observing the state of hydrogen in the JPARC moderator loop

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The spectrum moderators deliver to neutron scattering beamlines has to stay as consistent as possible throughout the runcycle of a facility. This means that for hydrogen moderators the ratio of parahydrogen to orthohydrogen especially needs to stay the constant. Especially low dimensional parahydrogen moderators are very sensitive to the ortho- to parahydrogen equilibrium and quickly lose their brightness when the orthohydrogen concentration becomes too high.

Keeping the moderator spectrum the same throughout operations poses a challenge with the increasing brightness of sources. High radiation fields present in the target area of these neutron sources cause the hydrogen in the moderator to convert from the desired parahydrogen to orthohydrogen thereby shifting the equilibrium to higher orthohydrogen contents than would be expected in non-irradiated hydrogen at equilibrium (e.g. 99.8% parahydrogen content at 20 K). One way of keeping the parahydrogen concentration high is using a catalyst such as ferric oxyhydroxide (FeOOH) in the hydrogen moderator loop to convert ortho- to parahydrogen. The continuous conversion of ortho- to parahydrogen allows to keep a high parahydrogen concentration in spite of a radiation field. This is being done at some spallation sources (ISIS, JPARC), and forseen at others (ESS, SNS). Some published results [Iverson, E.B. and Carpenter, ICANS-XVI(2003)707-718, M. Ooi et al. NIMA 566(2) (2006)699-705, M.Ooi, ICANS-XVI(2003) 801-808, G. Romanelli, J. Phys: Conf. Series 1021(2018)012055] suggest a back conversion rate for this reaction, however it has still not been directly observed.

We will present our first spectroscopic measurement of the hydrogen from the JPARC moderator. The parahydrogen to orthohydrogen ratio was measured with hydrogen released from the moderator loop during operations at 1 MW with the catalyst in place and after 3 hours of operations at 500 kW while bypassing the catalyst. Two different Raman setups were in use and the data of both is compared

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