Single-particle spectroscopy of exotic nuclei: the cases of 207Hg and 25F

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Single-particle spectroscopy is a traditional tool to understand the nuclear structure [1]. One reason is the direct comparison to the shell model calculation. Although it is an old well-established technique, new applications are still being explored to extend our understanding on nuclear structure.

We will present two distinct applications of single-particle spectroscopy. The first one is probing the neutron shell structure of the heavy neutron-rich isotope of 207Hg [2], which is located in an unexplored region beyond N=126 and below Z=82. The experiment was done in recently upgraded ISOLDE facility at CERN and taking advantage of the new ISOLDE Solenoid Spectrometer (ISS). The extracted single-particle energies can be explained by a simple Woods-Saxon potential. The extrapolation of the single-particle energies from 209Pb, towards the neutron unbound as one descends down *N* = 126 helps us to understand the *r*-process.

The second application is probing the neutron shell structure of 25F using quasi-free (p,2p) reaction [3]. The experiment was done in RIKEN using the SHARAQ spectrometer. This novel technique is interesting probe for studying “proton-magic plus one” nuclei. The study found that an additional proton on top of 24O dramatically changes the neutron shell structure of 24O itself. The result could advance our understanding of the oxygen dripline anomaly.

Transfer and knockout reactions show great promises to reveal the secret of nuclear structure of exotic nuclei, when carried out in inverse kinematics. These techniques will continuously flourish with upgrades to the HELIOS at Argonne, the ISS at CERN. Moreover, a great potential will be in the FRIB era either for the reaccelerated beams with the next generation solenoidal spectrometer, SOLARIS, or with fast beams using the S800 spectrometer and in the future the HRS.

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| [1] | G. R. Satchler, Introduction to Nuclear Reaction, New York: Oxford University Press, 1990. |
| [2] | T.L. Tang, B. P. Kay, C.R. Hoffman, J. P. Schiffer, D. K. Sharp, L. P. Gaffeny, S. J. Freeman, M. R. Mumpower, *et al.,* "First Exploration of Neutron Shell Structure below Lead and beyond N=126," *Physical review letters,* vol. 124, p. 062502, 2020. |
| [3] | T. L. Tang, T. Uesaka, S. Kawase, *et al.*, "How Different is the Core of 25F from 24Og.s.?," *Physical review letters,* vol. 124, p. 212502, 2020. |