Nuclear physics' interdisciplinary progress

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The theoretical view of the structure of the atom nucleus is not carved in stone. Particularly, nuclear physics research could benefit from approaches found in other fields of physics. Reflections on these aspects were just released in a new type of rapid publications in the new Letters section of EPJ A, which provides a forum for the concise expression of more personal opinions on important scientific matters in the field. In a Letter to the *EPJ A* Editor, Pier Francesco Bortignon and Ricardo A. Broglia from the University of Milan, Italy, use, among others, the example of superconductivity to explain how nuclear physics can extend physical concepts originally developed in solid state physics.

Based on this example, they believe young nuclear physicists have the opportunity to bring their results to practitioners in other fields of research. Conversely, they also need to rise to the challenge of using new insights and techniques from other disciplines to question the validity of their own theories and make nuclear physics research more powerful.

The atomic nucleus is a self-bound system. Within it, elementary atomic nucleus particles or nucleons move with equal ease independent of each other or collectively. This dual movement makes it possible for the atomic nucleus to spontaneously deform into a cigar-like shape, for instance. And then it can start behaving like a miniature spinning top in what physicists call the spontaneous symmetry-breaking restoration phenomenon. Nuclear physics have previously shed light on such broken symmetry phenomena. Indeed, when deformation takes place in the abstract space related to the conservation of the number of nucleons, known as gauge space, broken symmetry is intimately connected with

nuclear superfluidity, similar to superconductivity in metals.

Solid state physicists have previously described the microscopic theory of superconductivity - by relating superconductivity to the macroscopic occurrence of pairs of electrons bound into so-called Cooper pairs.

Nuclear physicists have extended the solid state physics results to the limit of a single Cooper pair and studied Cooper pair tunneling to individual quantum states - something which is not possible in solid state physics. This, the authors believe, should stimulate further nuclear physics interpretation of results from other physics disciplines.

More information: P. F. Bortignon et al, Challenges in the description of the atomic nucleus: Unification and interdisciplinarity, *The European Physical Journal A* (2016). DOI: 10.1140/epja/i2016-16064-7

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