The data-based research project: Can the concept of a level scheme be of interest for the basic physics research?

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Level and decay schemes are par excellence the graphical means to present nuclear structure data. They are used for this purpose by scientific and nuclear data evaluation communities. However, especially for the Evaluated Nuclear Structure Data File (*ENSDF*) evaluation community, level schemes are also of technical interest in order to present the published data in a standard way. Beyond the technical interest, an important question remains: *Can the concept of a level scheme be of interest for the nuclear research itself?*

Level schemes are 2*D* graphs where the information is correlated on the vertical energy scale, accompanied by an arbitrary scale on the horizontal direction, where different bands of a nucleus can be interspersed in a diversity of ways as long their interconnecting transitions are preserved.

To get to the new concept of level scheme, the ensemble of experimental bands' gamma-ray energies as function of spin I can first be described on average as a beam of parallel lines, $2c(2I+k-1)$, with the inertial parameter $c = \hbar^2/2\mathcal{J}$, where is $\mathcal{J}$ the moment of inertia of the nucleus. $2c$ is the constant average slope of the bands and the k integer numbers are the offsets of the bands. We can determine these parameters from a least-squares fit from the $\Sigma(E\gamma(I)/2c-(2I+k-1))^2$=min condition applied simultaneously to all the bands of a nucleus. From $2c$ we can also deduce the effective second order moment of inertia, $\mathcal{J}^{(2)}_{eff} = \frac{\hbar^2}{2c} = const$, that describes the average rotational motion of the real rotational bands.

From the $2c(2I+k-1)$ parametrization we can build the *3D Double Helix discrete geometrical structure, the prototype for the new high-spin level schemes*.

Secondly, the regular experimental gamma-ray energy can be decomposed as $E\gamma=2c(2I+k-1+k'+fn)$, with $(k'+fn)$ being the deviation of the experimental $E\gamma$ value from its $(2I+k-1)$ average value we got from the fit, with k' an integer number and fn a fractional quantity respectively. This can be also written as $E\gamma=2c_{band}(2I+k+k'-1)$ and $2c_{band}=2c[1+fn/(2I+k+k'-1)]$, with $2c_{band}$ and $(2I+k+k'-1)$ real and integer numbers, respectively. Then band second order moment of inertia can be easily obtained, $\mathcal{J}^{(2)}_{band} = \hbar^2/2c_{band}$. This decomposition gets a complete description of the experimental bands of a nucleus.

The $2c_{band}(2I+k+k'-1)$ expression allows the unitary 3*D* representation of decay paths of the rotational bands on the Double Helix, as seen in Fig. 1 for the ^{171}Yb nucleus (data from ref [1]). *Their apparent rotations (precessions) on the Double Helix are due to the combined macroscopic and microscopic nuclear motions.*

Double Helix defines a Semiclassical Meta-Trajectory through the series of $(2I+1)$ generalized discrete angular momentum states available for the rotational motion of the nucleus as a whole for each I value. One can assume that:

On average Nuclear Matter's Motion itself follows the Semiclassical Meta-Trajectory of the Double Helix, on which the actual levels are selected by the rotational bands' paths. *Ultimately, Nuclear Matter's Double Helix Motion can be seen as a Semi-Classical Vortex Motion.*

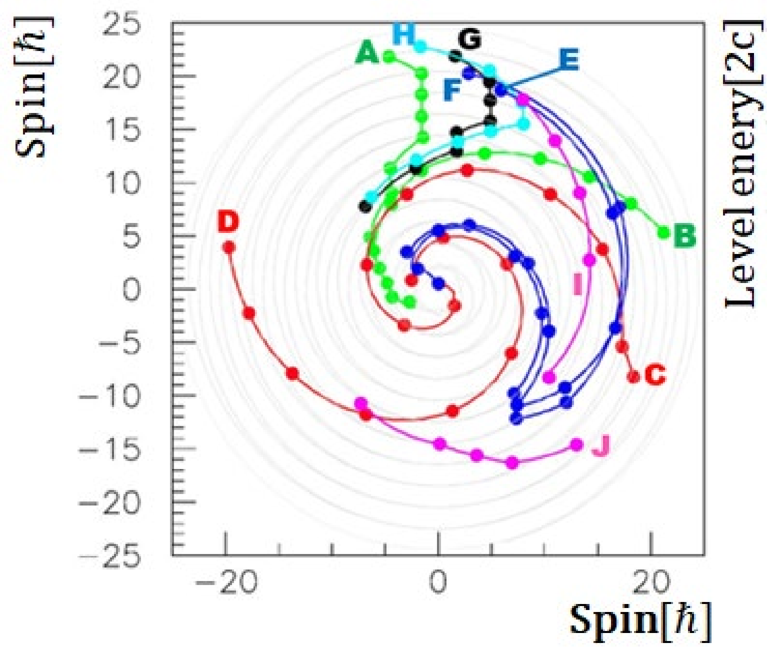

FIG. 1**.** Double helix level scheme of the rotational bands of the ^{171}Yb nucleus (2D projection view from above)

[1] D.E. Archer *et al.*, Phys. Rev. C **57**, 2924 (1998).