

Scissors mode in ^{254}No

M. A. Mardyban^{1,2*}, V. O. Nesterenko^{1,2}

¹Joint Institute for Nuclear Research, Dubna, Russia

² Dubna State University, Dubna, Russia

*e-mail: mmardyban@mail.ru

Low-energy multipole excitations in nobelium isotopes are of considerable interest both from the viewpoint of the structure of superheavy deformed nuclei and in connection with recent experimental data on M1 excitations in ^{254}No [1]. In the present work, the low-energy spectrum of ^{254}No is investigated within the fully self-consistent Quasiparticle Random Phase Approximation (QRPA) using Skyrme forces [2], [3]. This study continues our previous investigation of low-energy collective excitations in nobelium isotopes, where number of characteristic structural features of $^{250-260}\text{No}$ were analyzed within the same microscopic framework [4].

In our calculations, transition probabilities $B(M1)$ are also found for low-energy $K^\pi=1^+$ states. However, the analysis of the microscopic structure of these excitations and the corresponding velocity fields shows that a large $B(M1)$ value alone is not a sufficient criterion for an unambiguous identification of a state as an orbital scissors mode. According to our results, the dynamics of these states differs substantially from the classical picture of the scissors-like oscillation of proton and neutron subsystems.

In this work, the orbital and spin contributions to M1 transitions, as well as their mutual interference, are analyzed in detail. It is shown that both constructive and destructive interference between the orbital and spin parts of the M1 operator can occur in the low-energy spectrum of ^{254}No . This interference has a significant impact on the resulting $B(M1)$ values and on the physical interpretation of the corresponding states. In addition, the role of quadrupole oscillation, in particular the influence of $B(E2)$, on the overall dynamics of low-energy excitations is considered. Such a combined analysis of M1 and E2 characteristics allows a more reliable separation of genuine collective modes from states with large transition probabilities caused by the mixing of different microscopic structures.

The obtained results demonstrate that the interpretation of M1 excitations in superheavy deformed nuclei requires not only an analysis of integral $B(M1)$ values, but also a detailed investigation of the spin-orbital structure, transition densities, and velocity fields.

References

1. F. L. Bello Garrote [et al.], Phys. Lett. B **834**, 137479 (2022).
2. P.-G. Reinhard, B. Schuetrumpf, J. A. Maruhn, Comp. Phys. Commun. **258**, 107603 (2021).
3. A. Repko, J. Kvasil, V. O. Nesterenko, P.-G. Reinhard, arXiv:1510.01248[nucl-th].
4. V. O. Nesterenko, M. A. Mardyban, R.V. Jolos, P.-G. Reinhard, A. Repko, A. A. Dzhioev, Phys. Rev. C **111**, 064322 (2025).