A recent study \cite{Ref1} introduces the parameterization NL-RA1 of the relativistic mean-field model (RMF). It is left open which data NL-RA1 is fitted to, which prevents to relate its properties to the fitting strategy. NL-RA1 is compared with early parameterizations as NL1 or NL-SH, more recent ones as NL3 or NL-Z2 are not considered. Extrapolation of NL-RA1 to superheavy nuclei contradicts earlier studies. As will be shown here, conclusions drawn in \cite{Ref1} may be doubtful as the pairing model used is unrealistic, and nuclei known to be deformed are calculated assuming spherical shapes.

Ref. \cite{Ref1} employs two parameterizations of the constant-gap model, one of which ($\Delta I$) has been used in many early applications of the RMF. The pairing matrix elements are independent on the single-particle levels which is unrealistic for loosely-bound systems \cite{Ref2} as those discussed in \cite{Ref1}. The pairing gap, related to the odd-even mass staggering, has to be parameterized as a function of $N$ and $Z$ \cite{Ref3}. Model $\Delta I$ describes the average behaviour of the pairing gap. Introducing about 30 parameters $N_{c1}$ and $N_{c2}$, model $\Delta II$ attempts to incorporate the reduction of the pairing gap around known magic numbers, but remains arbitrary for exotic systems where shells might be quenched or new shells occur. Model $\Delta II$ misses the overall reduction of the pairing gap with $A$, see Fig. 1. For transactinides, gaps are overestimated by a factor of 3. (There is currently much discussion about blocking and mean-field contributions to calculated pairing gaps that are neglected here, see \cite{Ref4,Ref5} and references therein. Those corrections cannot be easily incorporated into the simplistic constant gap model. Their contribution is usually smaller than 20\% and decreases with $A$.) There is no justification for model $\Delta II$ as it fails by construction to describe the size of the pairing gap, which is the key observable for pairing correlations. As the pairing gap determines the occupation of the single-particle states around the Fermi surface, most results presented in \cite{Ref1} are affected in one way or the other.

In \cite{Ref1}, the predictive power of NL-RA1 for superheavy nuclei is tested for the heaviest known even-even nuclei as earlier done in \cite{Ref6}. Results in \cite{Ref1} differ significantly from \cite{Ref6}. One reason are different pairing models, but there is a second one. In \cite{Ref1} it is not mentioned which shape degrees of freedom are accounted for. Repeating the calculations indicates that all results in \cite{Ref1} are obtained assuming spherical shapes. This is consistent with experiment for Sn and Pb isotopes, but there is agreement among all successful mean-field models that the known superheavy nuclei are deformed. This is confirmed by experiment for selected isotopes up to $^{254}$No \cite{Ref7}. In \cite{Ref1} the missing deformation energy (which is on the order of
FIG. 3. Single-particle spectrum of the protons, pairing gap $\Delta_p$ in model $\Delta II$, difference $\Delta E$ between the binding energy obtained with model $\Delta I$ and $\Delta II$, and two-proton gap $\delta_{2p}$ (all in MeV) for $N = 184$ isotones. The uppermost panel also displays the occupation probability $\nu^2_k$ for the protons in $^{298}114$ calculated with model $\Delta I$. The arrows denote the pairing gap $\Delta_p$, $\epsilon_p$ the Fermi energy. Results for $^{298}114$ depend sensitively on the value of $\Delta_p$. Filled (open) markers denote calculations where $\Delta_p$ for $^{298}114$ is calculated using the prescription for nuclei with $N$ smaller (larger) than $Z = 114$. (Ref. [1] leaves it open which one to use. Results presented there correspond to filled markers).

$10$ MeV or $0.5\%$ is replaced by the artificially increased pairing correlation energy from model $\Delta II$. Using a more realistic state-dependent delta pairing force with parameters adjusted along the strategy of [4] and allowing for deformation change significantly the systematics of $\delta E$ for transactinide nuclei, see Fig. 2. Comparing with Fig. 17 in [1], all forces perform better. Similar changes can be expected for the values given in Fig. 18 of [1] (see [8] for complications when calculating odd- $A$ nuclei which are neglected in [1]). The change in $\delta E$ when comparing NL1 with NL-Z and NL-Z2 reflects an improved center-of-mass correction [9] and the inclusion of data on exotic nuclei into an otherwise identical fit. NL-RA1 and NL-Z2, however, have the same good quality for binding energies of transactinide nuclei in spite their very different nuclear matter properties.

In the framework of mean-field models, a magic number is associated with a large gap in the single-particle spectrum which causes a discontinuity in the systematics of binding energies. Those (and other) discontinuities are filtered from data with the two-proton gap $\delta_{2p}(N,Z) = E(N,Z-2) - 2E(N,Z) + E(N,Z+2)$ and the similar quantity for neutrons. $\delta_{2p}$ has to be taken with care, as it assumes the structure of the considered nuclei does not change, which is not necessarily fulfilled for heavy nuclei [10]. Ground-state deformation of some of the nuclei might quench $\delta_{2p}$ and has to be considered as soon as one wants to predict future data on these nuclei. To demonstrate the non-existence of the spherical $Z = 114$ shell, however, spherical calculations are sufficient and enforce the validity of $\delta_{2p}$ as a signature for magicity. Figure 3 displays the key quantities that reveal the origin of the large $\delta_{2p}$ for $^{298}114$ found in [1]. Let us look at filled markers first. Single-particle energies in $^{298}114$ do not change significantly when varying the pairing strength. The pairing gap for $^{298}114$ from model $\Delta II$ ($\Delta_p = 1.7$ MeV) is of the same order as the $Z = 114$ gap in the single-particle spectrum (1.4 MeV). About 3 protons occupy levels above the $Z = 114$ gap, inconsistent with the assumption of a major shell closure. By construction, $\Delta_p$ drops by a factor 2 at $Z = 114$. This causes a discontinuity in the pairing correlation energy which is clearly visible when comparing binding energies obtained with models $\Delta I$ and $\Delta II$.

The discontinuity in the pairing correlation energy built into model $\Delta II$ causes the large value for $\delta_{2p}(^{298}114)$ found in [1], not the underlying shell structure. This is confirmed when moving the discontinuity of $\Delta_p$ to the non-magic proton number $Z = 112$, see the open markers in Fig. 3. $\delta_{2p}$ is now peaked at $^{296}112$, which has no closed spherical proton shell. $\delta_{2p}$ cannot be used as a signature for shell closures when as the pairing gap and its fluctuations are of similar size as the spacing of single-particle energies. However, the size of the pairing gap in model $\Delta II$ is unrealistic anyway. Calculations with more realistic pairing models do not show any significance for a major shell closure at $Z = 114$, consistent with [11].

The $Z = 120$ shell is not considered in the choice of $N_{c1}$ and $N_{c2}$ in pairing model $\Delta II$, the pairing gap has huge mid-shell values there. This smears out the $Z = 120$ shell effect found in [11] in terms of $\delta_{2p}$ (c.f. Fig. 21 in [1]) but again does not affect the single-particle spectra.

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