At the extremes of nuclear charge and spin*

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In 1834 C.G.J. Jacobi made a startling discovery which led to the realisation that, at a certain critical angular momentum, the stable equilibrium shapes of a gravitating mass rotating synchronously (i.e., with all mass elements sharing a common angular velocity) changes abruptly from a slightly oblate spheroid to a triaxial ellipsoid rotating about its shortest axis [1]. In 1961 the suggestion was made in [2] that a similar phenomenon might be expected in the case of atomic nuclei idealized as charged, incompressible liquid drops endowed with a surface tension. This was confirmed and quantified in 1974 [3] and 1986 [4]. In 1996 the oblate-to-triaxial transition was demonstrated also in the more realistic self-consistent, semi-classical Thomas-Fermi model, under the same assumption of synchronous rotation [5]. The Thomas-Fermi model provides a good description of shell-averaged static nuclear properties, but the assumption of synchronous rotation is known to be strongly violated at low angular momenta, where measured moments of inertia are considerably smaller than the 'rigid-body' values implied by synchronous rotation. In the first part of the present paper we provide: a) closed formulae that represent accurately the energies and fission barriers of synchronously rotating Thomas-Fermi nuclei in the range of masses where the Jacobi transition takes place, and b) modified formulae that take account of the decreased moments of inertia at low angular momenta.

The formulae are useful in guiding experimental searches for the Jacobi transition in nuclei. The above analytical results agree to within one or two MeV with massive 'cranked-Strutinsky' computer calculations of fission barriers in the mass region A=100 to 122 at angular momenta of $60\hbar$ and $70\hbar$.

In the second part of the paper we discuss certain aspects of the dynamics of nucleus-nucleus fusion, and we sketch a possible way of estimating fusion cross sections for the sythesis of heavy and superheavy nuclei.

*Extracted from Ref. [6]

[1] S. Chandrasekhar, *Ellipsoidal Figures of Equilibrium*, Yale University Press, New Haven and london, 1969.

[2] R. Beringer and W.J. Knox, Phys. Rev. **121**, 1195 (1961).

[3] S. Cohen, F. Plasil and W.J. Świątecki, Ann. Phys. (N.Y.) **82**, 559 (1974).

[4] A.J. Sierk, Phys. Rev. **C 33**, 2039 (1986).

[5] W.D. Myers and W.J. Świątecki, Acta Physica Polonica **27A**, 99 (1996); Nucl. Phys. **A 612**, 249 (1997).

[6] W.D. Myers and W.J. Świątecki, Talk presented at the XXXV Zakopane School of Physics, Zakopane, Poland, 5-13 September 2000, to appear in Acta Physica Polonica; LBNL-4705, 30 October, 2000.