What is available?

- HFB codes
- HFB schemes/basis selection
Brussels-Saclay HFB code
Heenen, Bonche, Flocard, Terasaki: NPA 600, 371 (1996); based on earlier HF+BCS code ev8, Krieger et al., NPA542, 43 (1992)

Two-basis method; Rectangular coordinate space; Discretization mesh step 1 fm; Energy cut-off: 5 MeV; eigenstates of determined by imaginary time method
• used in recent GCM applications
• lacking continuum space to describe dripline physics

Fig. 1. Diagonal matrix elements of the HF hamiltonian in the neutron canonical basis for $^{64}$Ni. The calculation is performed with 70 neutron single-particle wave functions as a function of the box size $R$. Solid and dashed curves denote positive and negative parity levels, respectively. The numbers of quasi-degenerate levels corresponding to each resonance are indicated in parenthesis.
Canonical-basis HFB code

Tajima, nucl-th/0503036, nucl-th/0307075

Large energy cut-off; cubic box: L=40 fm; spacing 0.8 fm; gradient method
• no need for quasiparticle states
• used in large-scale SIII mass calculations
• pairing kinetic term added

http://serv.apphy.fukui-u.ac.jp/~tajima/isnd/isnd.html

FIG. 1: Comparison between the HF orbitals and the HFB canonical-basis orbitals. See text for explanations.
Brussels HFB code


Two-basis method; axial HO basis; 23 deformed shells; energy cut-off: 15 MeV;
• used in large-scale mass calculations: HFB-n (n=1-9)
• odd-particle treated by filling approximation
• ZPE corrections added
• ...
• most recent mass table

HFB-THO code
Stoitsov, Dobaczewski, Nazarewicz
Expansion in HO or THO basis; 20-24 shells; axial symmetry; large pairing cut-off
• full PNP (before variation) implemented
• pairing regularization tested
• several e-e mass tables produced

http://www.fuw.edu.pl/~dobaczew/thodri/thodri.html
HFBRAD code
Dobaczewski et al., nucl-th/0501002
Spherical (1D) HFB solver in coordinate space. Direct integration of HFB equations
• excellent for benchmarking

HFODD code
Expansion in 3D HO basis; 20-24 shells; all symmetries broken
• applied to description of high-spin chiral bands, magnetic rotors, superdeformed states, triaxial octupoles

http://www.fuw.edu.pl/~dobaczew/hfodd/hfodd.html
Benchmarking of HFB Codes: HFODD, HFBTHO, HFBRAD
(see nucl-th/0404077 for details)
Spherical and deformed nuclei

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Vanderbilt axial HFB-2D-LATTICE code

Cylindrical coordinate space; B-spline technique;
Mesh step 0.8 fm; Checked against HFBTHO; Slow

nucl-th/0502063

FIG. 9: (Color online) Linear plot of the normal neutron and proton density for the dripline nucleus $^{122}\text{Zr}$ as a function of distance $r = \sqrt{\rho^2 + z^2}$. Comparison between the HFB-2D-THO code and the HFB-2D-LATTICE code.
Gogny HFB codes

Bruyeres, Madrid

Expansion in HO basis; 10 spherical shells
- various applications
- D1S usually used, but new Gogny forces are coming
- Recent D1S deformed mass table


RHB codes

Zagreb-Munich group: Vretenar, Ring, Lalazissis, König, Niksic….

Expansion in HO basis; 14/20 spherical shells for fermions/bosons
- Gogny D1S pairing
- Contact pairing and regularization nucl-th/0503078
Basis selection

Choice depends on problem tackled

- Ground-state mass table e-e (axial solver, basis expansion sufficient)
- Ground-state mass table odd-A (axial symmetry broken, basis expansion sufficient)
- Fission, dynamics (all symmetries broken, several choices for the basis)
Related problem: heavy-ion fusion

- nucleus-nucleus potentials
- fusion barriers

J. Skalski, submitted. Coordinate-space Skyrme-Hartree-Fock
(see also nucl-th/0402033)
Wavelets

Multiwavelets provide high-order convergence and readily accommodate singularities and boundary conditions.

The wavelet function (mother wavelet) is orthogonal to all functions which are obtained by shifting the mother right or left by an integer amount. Furthermore, the mother wavelet is orthogonal to all functions which are obtained by dilating (stretching) the mother by a factor of $2^j$ and shifting by multiples of $2^j$ units. The collection of shifted and dilated wavelet functions is called a wavelet basis. The grid in shift-scale space on which the wavelet basis functions are defined is called the dyadic grid.

The great interest in wavelets today is only partly due to their ability to efficiently represent functions with localized features.