(7) as well as the relations between the centrifugal barrier and the spin-orbit potential will be investigated.

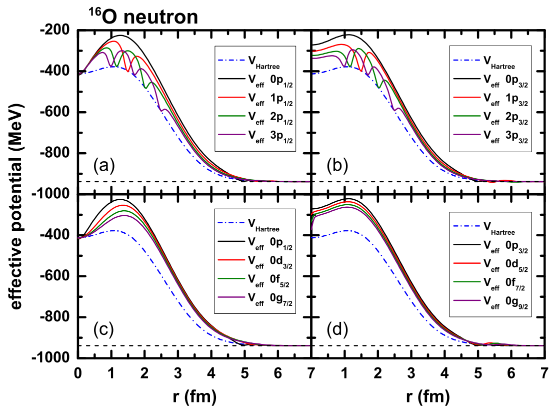

FIG. 4: (color online) Effective potentials in the negative energy spectrum of ^{16}O calculated by DDRHF with PKO1, (a) for states $np_{1/2}$ with $n = 0, 1, 2, 3$, (b) for states $np_{3/2}$ with $n = 0, 1, 2, 3$, (c) for states $0p_{1/2}$, $0d_{3/2}$, $0f_{5/2}$, and $0g_{7/2}$, (d) for states $0p_{3/2}$, $0d_{5/2}$, $0f_{7/2}$, and $0g_{9/2}$. The Hartree part is labelled with dash-dotted lines.

The effective potentials V for p, d, f, and g states in the negative energy spectrum of ^{16}O calculated by DDRHF with PKO1 are shown in Fig. 4, together with the Hartree part V^D (dash-dotted line). As seen in the Schrödinger-type equation Eq. (7), the effective potential V is composed of two parts, V^D the Hartree potential from the direct terms, and V^E the equivalent local potential from the exchange terms. The state dependence of the effective potential V comes from the contribution of the exchange terms.

Corresponding to the nodes of the dominant component $F(r)$, there exist fluctuations in the effective potentials V, which is brought in by the localization of non-local terms X and Y in Eq. (4). In addition, the contributions of Fock terms to the effective potentials tend to be slightly weaker when $E_{\rm av}$ approaches the continuum limit, or for larger orbital angular momenta $\tilde{l}$.

Comparing the left and right panels of Fig. 4, it is found that the effective potentials at $r = 0$ are different between the spin partner states. This is due to the different asymptotic behaviors of the radial Dirac wave functions for spin doublets at $r = 0$,

$$\begin{aligned} \lim_{r\to 0} \frac{G(r)}{F(r)} &\propto r, \text{ for } \quad \kappa > 0, \\ \lim_{r\to 0} \frac{F(r)}{G(r)} &\propto r, \text{ for } \quad \kappa < 0. \end{aligned} \tag{9}$$