HFB calculations for nuclei with tetrahedral symmetry

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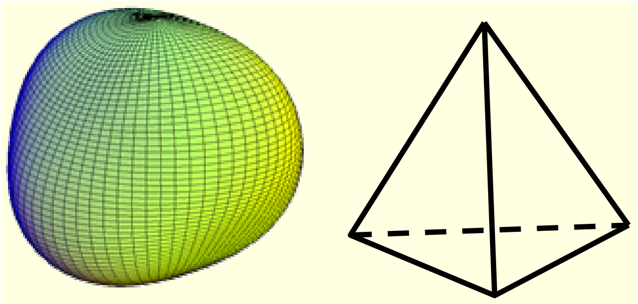
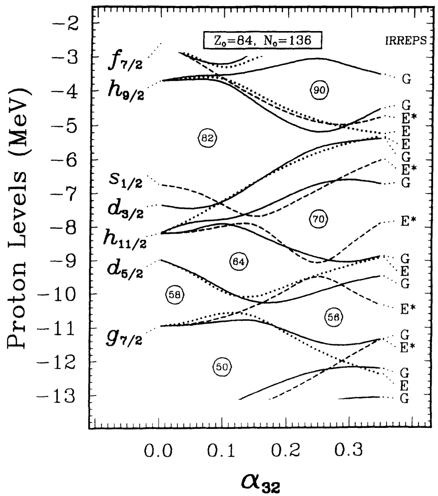
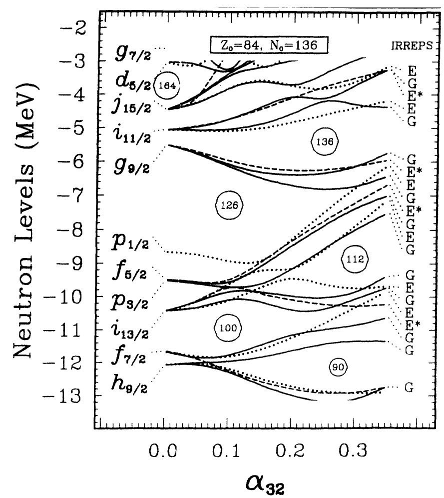


- Tetrahedral deformation
- Details of HFB calculations
- HFB tetrahedral and quadrupole solutions

Tetrahedral deformation

- Stability - gaps - degeneracy - symmetry
- Tetrahedral group: 2-fold and 4-fold degeneracy
- Shapes: β_{32}
- Single-particle levels:





- Tetrahedral magic numbers:

$$N/Z = 16, 20, 32, \mathbf{40}, \mathbf{56\text{-}58}, \mathbf{70}, \mathbf{90}\text{-}94, 100, 112, \mathbf{136}/126$$

X.Li, J.Dudek, Phys.Rev. **C49** (1994) 1250R

HFB calculations

- Particle-hole channel: Skyrme

SLy4, SkM*, SkP, SIII

- Pairing channel: Density-Dependent Contact Interaction

$$V(\vec{r}_1, \vec{r}_2) = V_0 \left(1 - \frac{\rho(\vec{r}_1)}{2\rho_0}\right) \delta(\vec{r}_1 - \vec{r}_2)$$

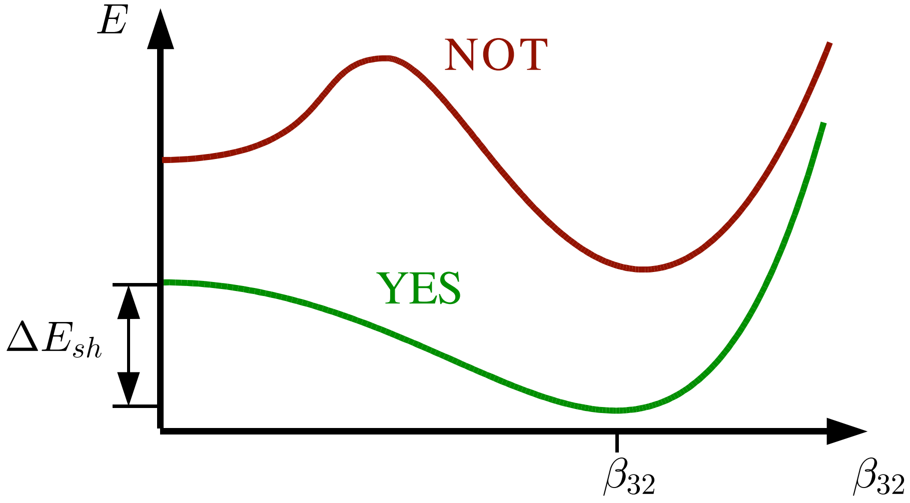
J.Dobaczewski, W.Nazarewicz, T.Werner, Physica Scripta **T56** (1995) 15

HFB results

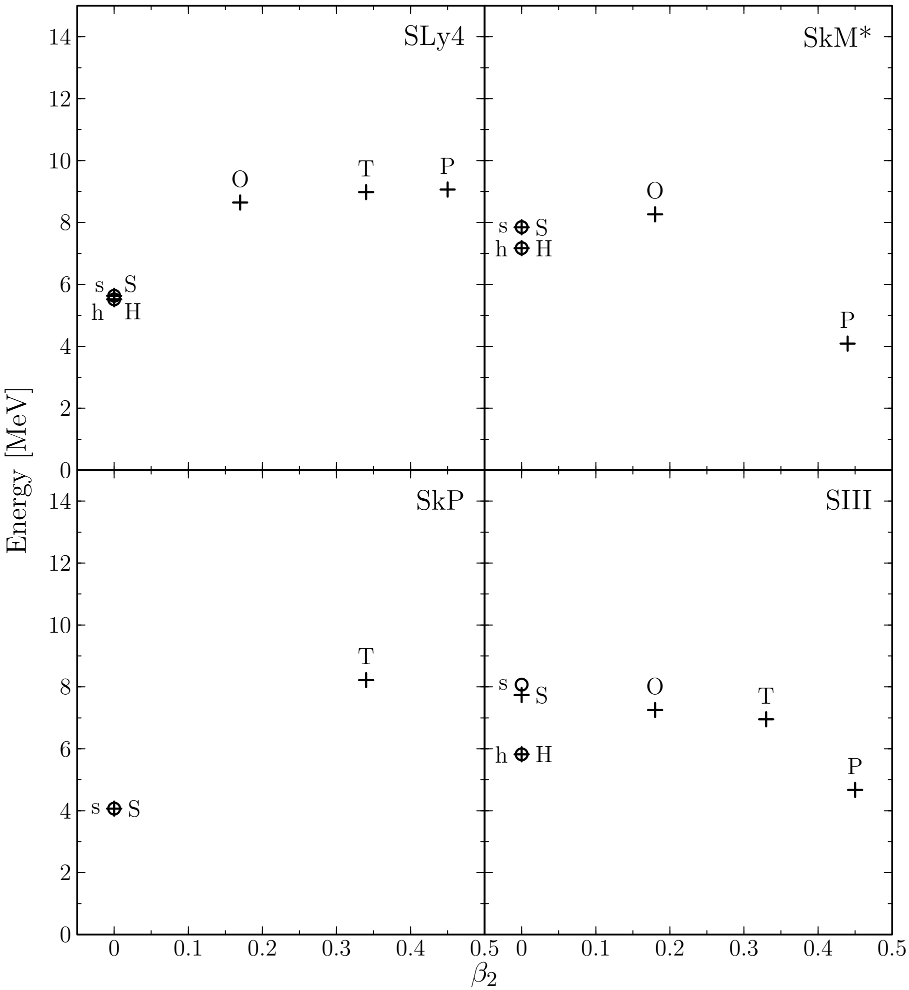
- Tetrahedral and quadrupole minima in:

$$^{80}_{40}\mathrm{Zr}_{40},\quad ^{98}_{40}\mathrm{Zr}_{58},\quad ^{110}_{40}\mathrm{Zr}_{70},\quad ^{126}_{56}\mathrm{Ba}_{70},\quad ^{160}_{70}\mathrm{Yb}_{90},\quad ^{226}_{90}\mathrm{Th}_{136}$$

- Points of interest: ΔE_{hq}, β_{32}, ΔE_{sh}

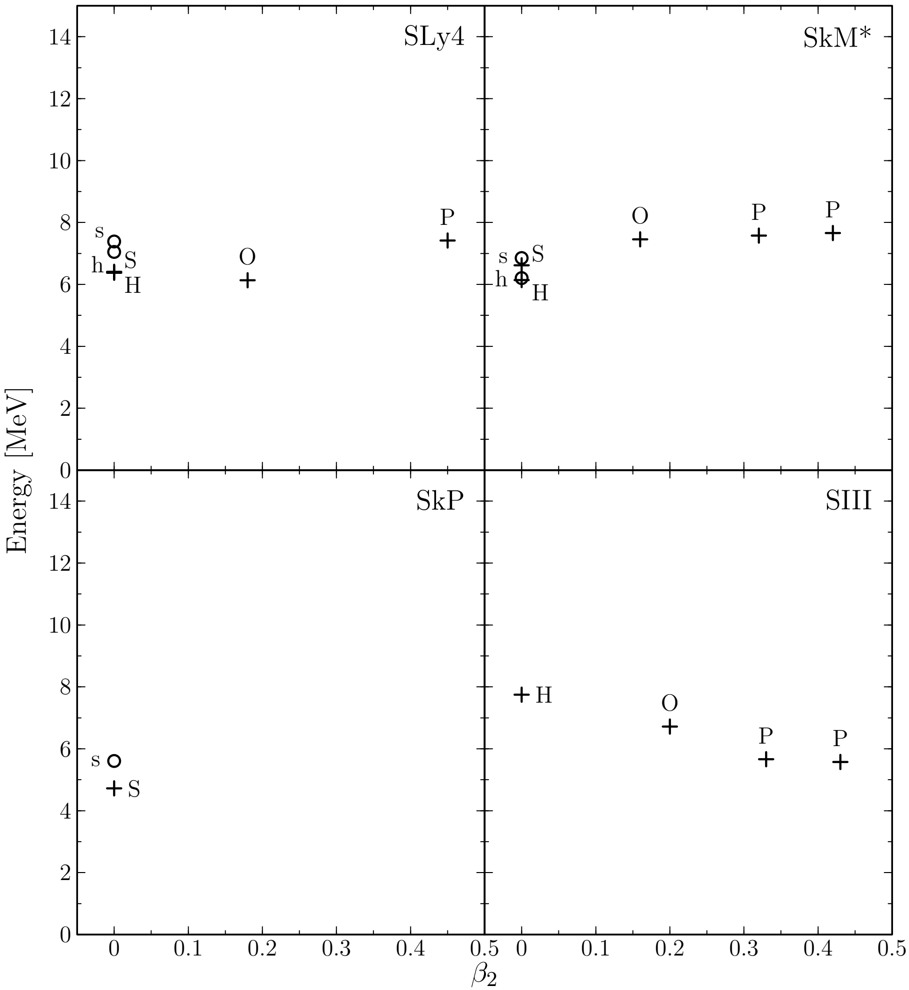


$^{80}_{40}\mathrm{Zr}_{40}$



	β_{32}	β_{32}^{δ}
SLy4	0.11	0.11
SkM*	0.16	0.16
SkP		
SIII	0.20	0.20

$$-3 < \Delta E_{hq} < 3\,\mathrm{MeV}$$

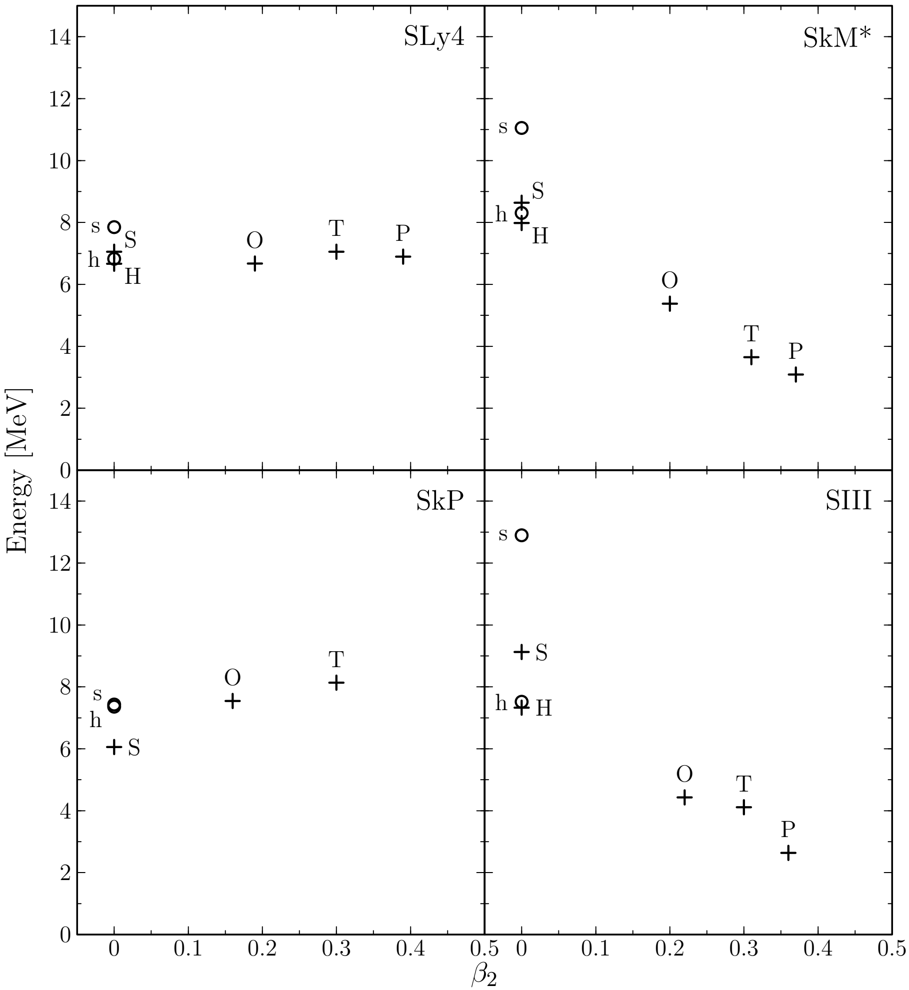


$^{98}_{40}Zr_{58}$

	β_{32}	β_{32}^{δ}
SLy4	0.14	0.09
SkM*	0.16	0.15
SkP		
SIII		0.20

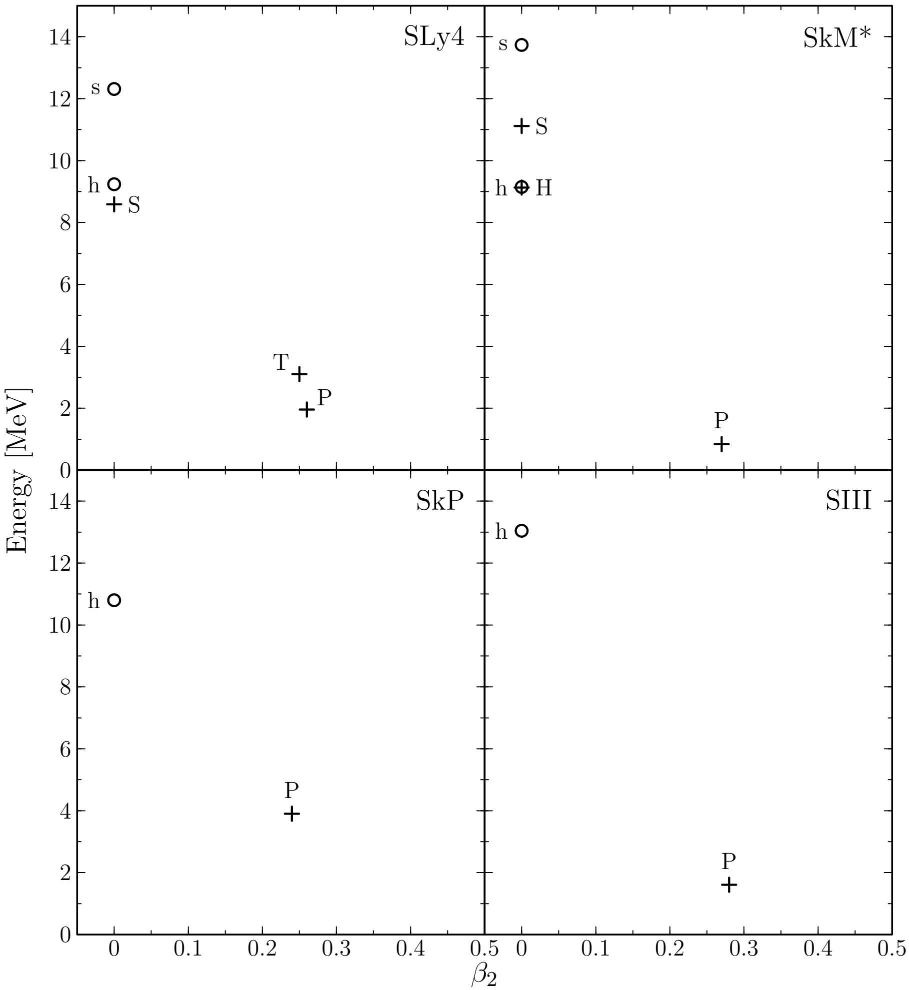
$$-1.5 < \Delta E_{hq} < 2\,\mathrm{MeV}$$

$^{110}_{40}\mathrm{Zr}_{70}$



	β_{32}	β_{32}^{δ}
SLy4	0.17	0.14
SkM*	0.20	0.16
SkP	0.08	
SIII	0.23	0.21

$$0 < \Delta E_{hq} < 5\,\mathrm{MeV}$$

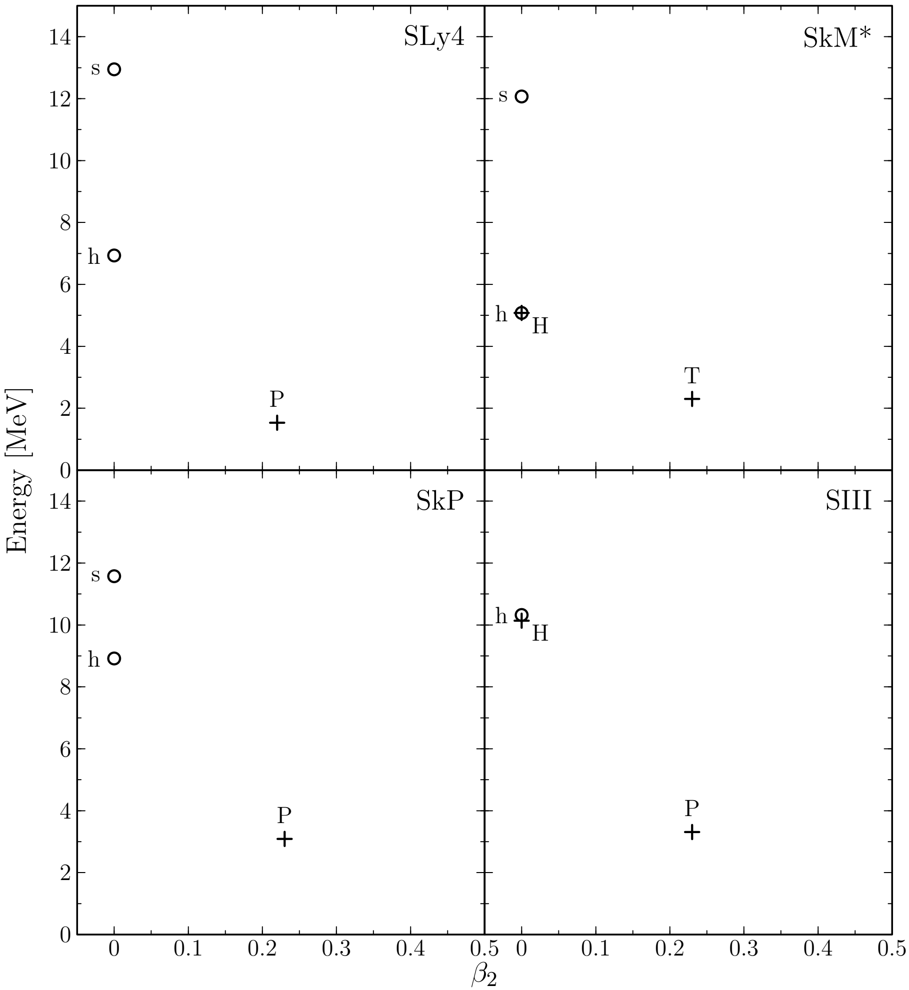


$^{126}_{56}\mathrm{Ba}_{70}$

	β_{32}	β_{32}^{δ}
SLy4	0.21	
SkM*	0.23	0.22
SkP	0.17	
SIII	0.26	

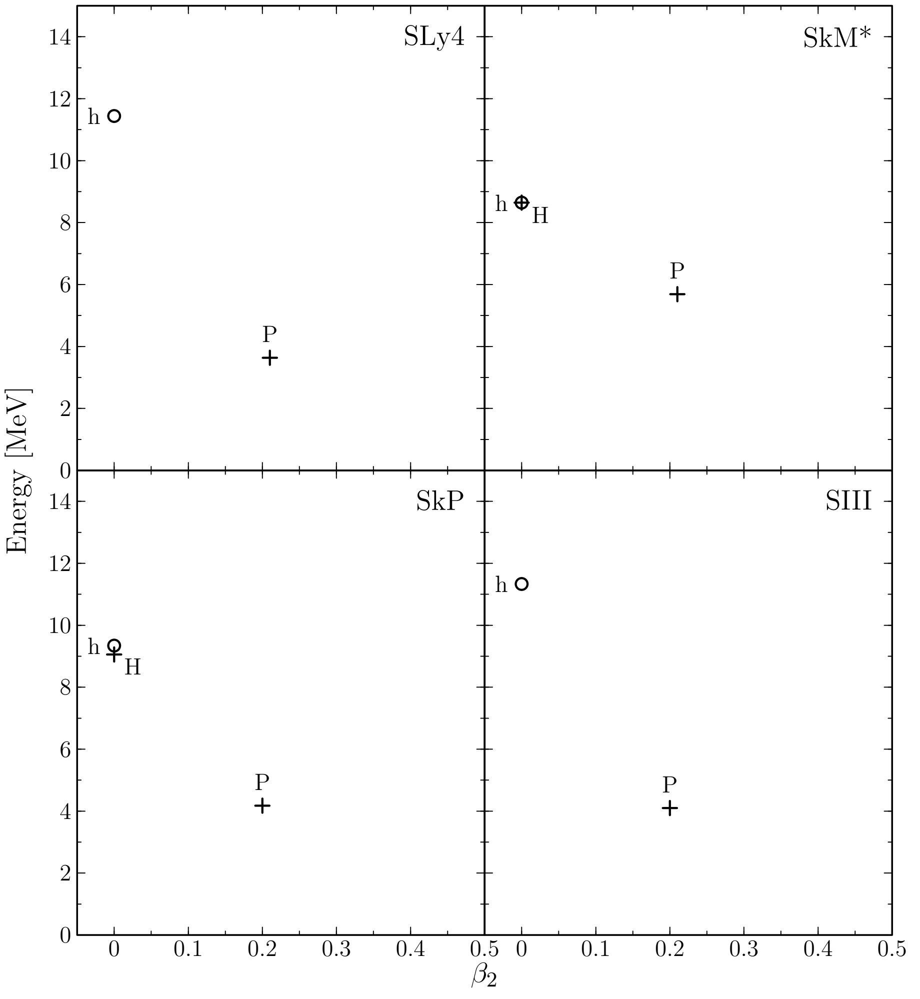
$$6 < \Delta E_{hq} < 11\,\mathrm{MeV}$$

$^{160}_{70}\mathrm{Yb}_{90}$



	β_{32}	β_{32}^{δ}
SLy4	0.23	
SkM*	0.23	0.23
SkP	0.19	
SIII	0.26	0.24

$$3 < \Delta E_{hq} < 7\,\mathrm{MeV}$$



$^{226}_{90}\mathrm{Th}_{136}$

	β_{32}	β_{32}^{δ}
SLy4	0.22	
SkM*	0.22	0.22
SkP	0.18	0.15
SIII	0.24	

$$3 < \Delta E_{hq} < 8\,\mathrm{MeV}$$

Conclusions

- HF and HFB tetrahedral solutions in doubly-magic nuclei exist
- Discrepancy in ΔE_{hq} and β_{32}, ΔE_{sh} between forces
- Pairing reduces β_{32}, ΔE_{sh}
- ΔE_{hq}: small in Zr, large in Ba, moderate in Yb and Th
- The heavier the nucleus the larger ΔE_{sh}

Collaboration

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- Jacek Dobaczewski, *Warsaw*
- Przemysław Olbratowski, *Warsaw*