# Theoretical Nuclear Physics Groups in China

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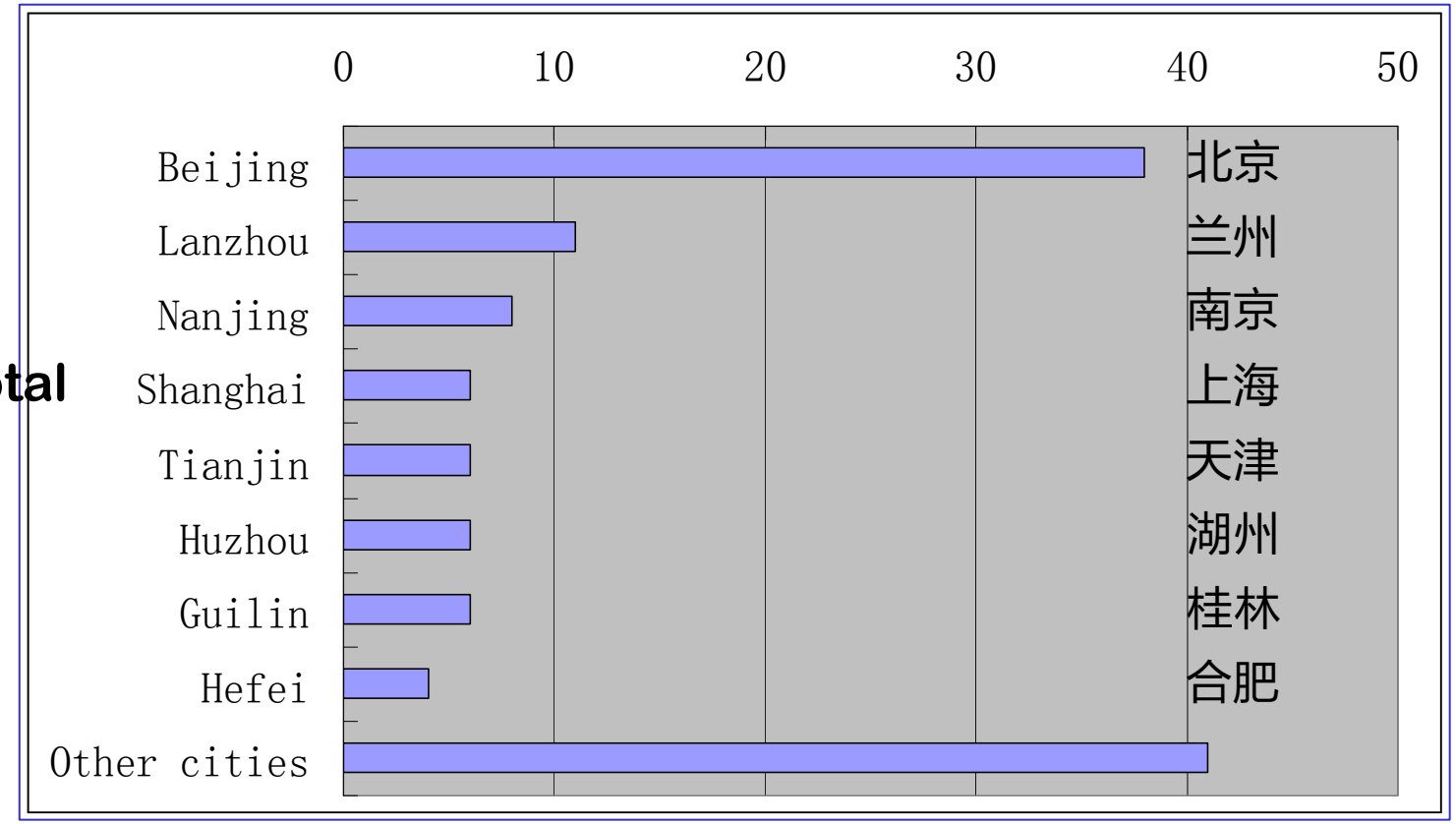
- List of groups
- Highlights of recent results
- Development of theoretical models

*RCNST Steering meeting*
*Nov. 1, 2011, Beihang Univ.*

# Theoretical Nuclear Physics Groups in China

- In 32 cities: 38 in Beijing, 11 in Lanzhou, 4 or more in Nanjing, Shanghai, Tianjin, Huzhou, Guilin, & Hefei
- In 53 institutions: *only one in 22 institutions*
- 24 female (about 20%)
- International collaborations

**126 in total**



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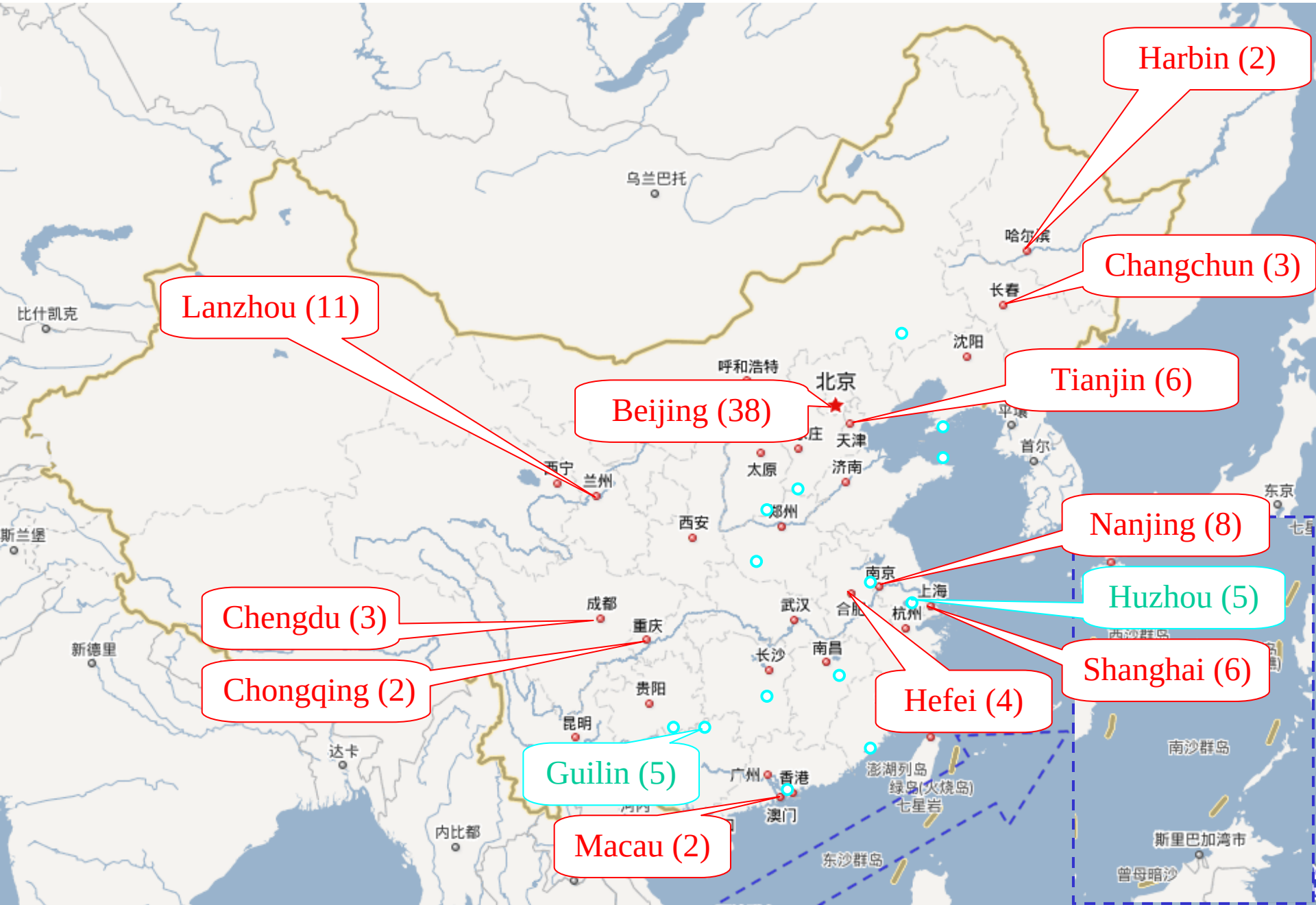

# Theoretical Nuclear Physics Groups in China


Harbin (2)

Changchun (3)

Tianjin (6)

Nanjing (8)

Huzhou (5)

Shanghai (6)

Hefei (4)

Chengdu (3)

Chongqing (2)

Guilin (5)

Macau (2)

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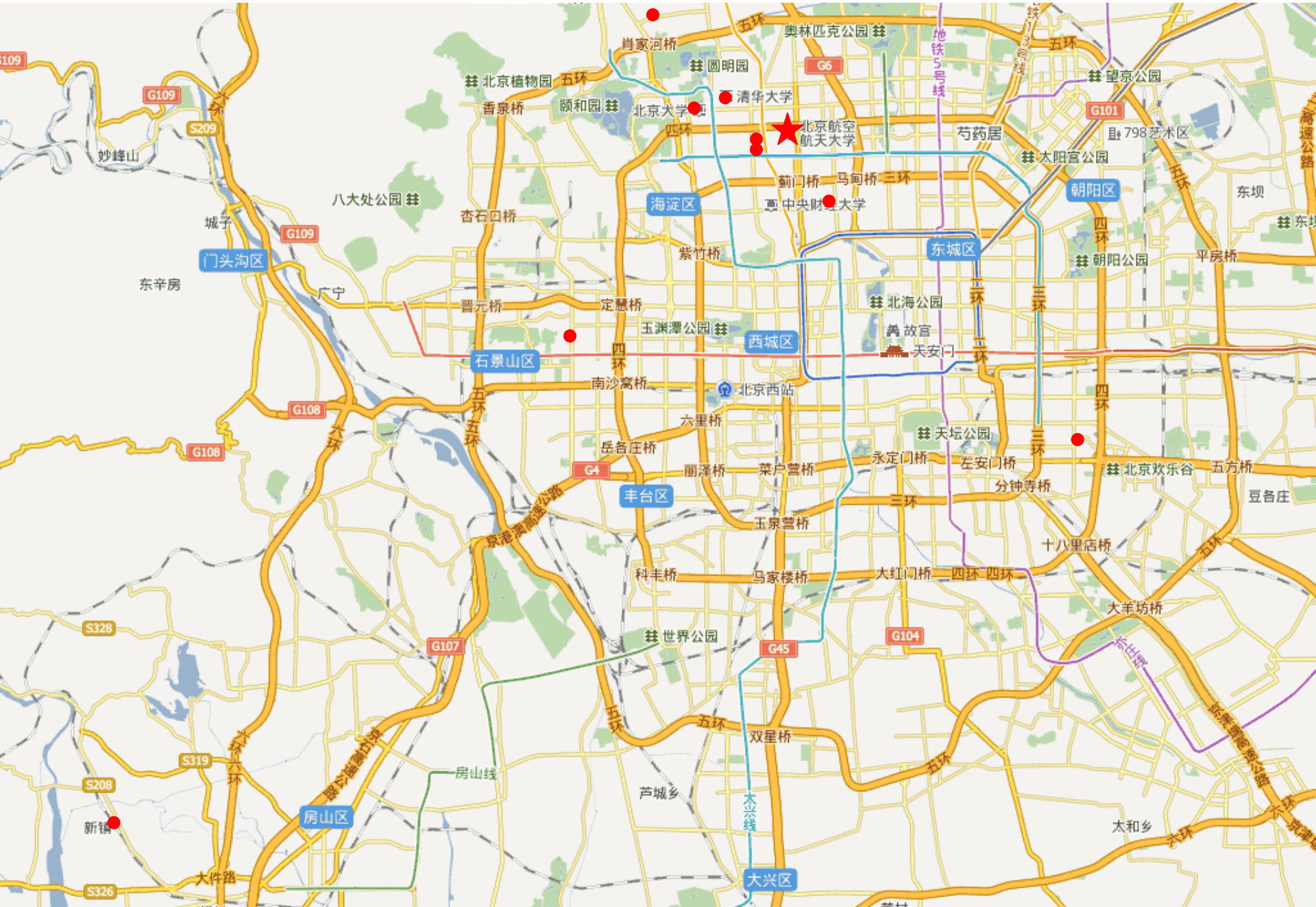


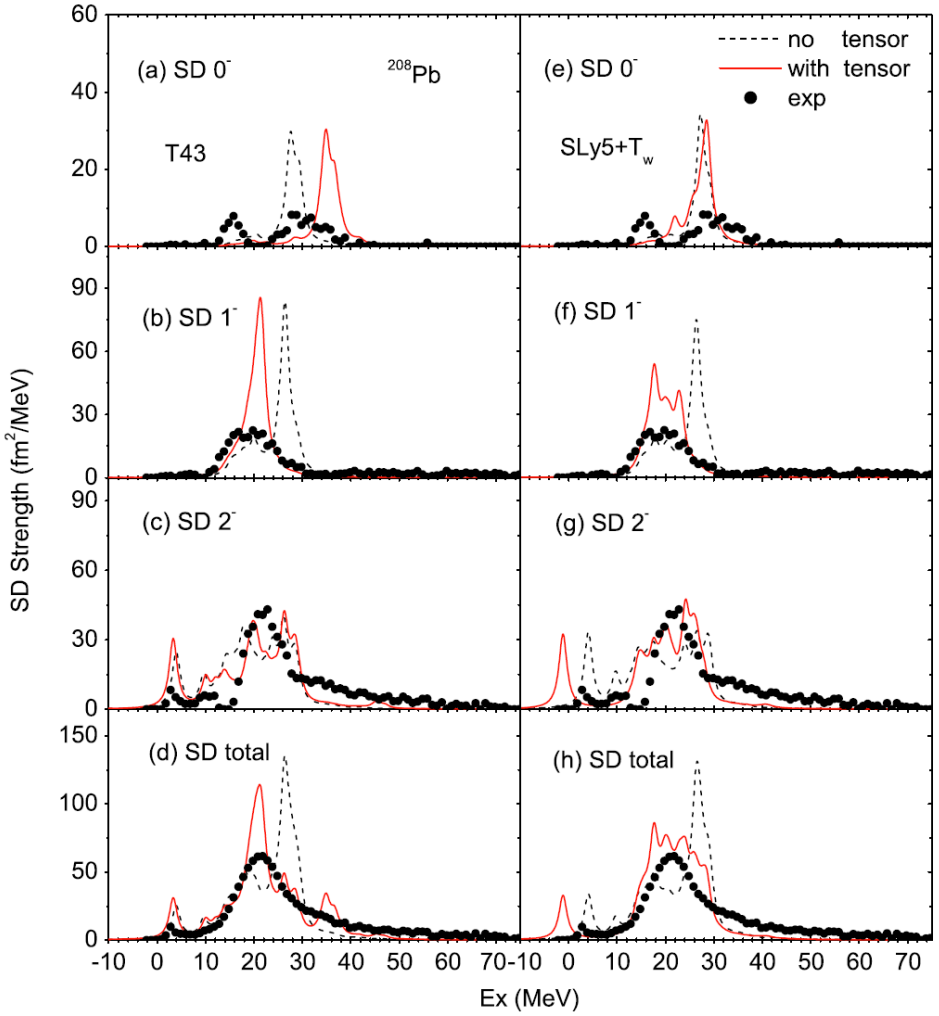
# Highlights: Effect of tensor force

PRL **105,** 072501 (2010) PHYSICAL REVIEW LETTERS week ending 13 AUGUST 2010

## Effect of the Tensor Force on the Charge Exchange Spin-Dipole Excitations of $^{208}$Pb

C. L. Bai,[1,2] H. Q. Zhang,[1,2] H. Sagawa,[3] X. Z. Zhang,[1] G. Colò,[4] and F. R. Xu[2]

- A fully self-consistent Skyrme Hartree-Fock plus RPA theory with tensor
- Tensor correlations have a unique & multipole-dependent effect on the SD excitations
  - ➢ Soften $1^-$ states
  - ➢ Harden $0^-$ & $2^-$ states




Bai_Zhang_Zhang_Xu_Sagawa_Colo2009_PRC79-041301R
Bai_Sagawa_Zhang_Zhang_Colo_Xu2009_PLB675-28
Bai_Zhang_Sagawa_Zhang_Colo_Xu2010_PRL105-072501

# Highlights: α decay of superheavy nuclei

PRL 107, 012501 (2011) PHYSICAL REVIEW LETTERS week ending 1 JULY 2011

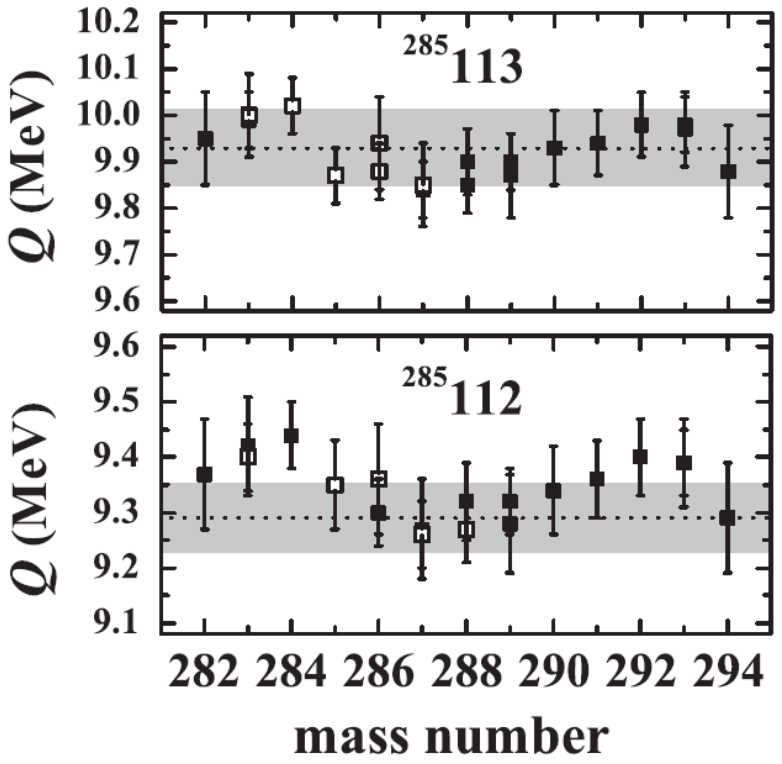
## Correlation between $\alpha$-Decay Energies of Superheavy Nuclei Involving the Effects of Symmetry Energy

Jianmin Dong,[1,2,3,4] Wei Zuo,[1,3,*] and Werner Scheid[4]

In general, if one selects $\xi = xZ + yN$ and $\beta$ as variables, the relationship between the $Q$ values of $\alpha$ decay can be written as

$$Q_2 = Q_1 - (\beta_2 - \beta_1)\left\{\frac{2^{5/3}}{9}a_c\xi^{2/3}[(1-\beta)x + (1+\beta)y]^{-5/3} \times [(1+\beta-2\beta^2)x + (11+5\beta+2\beta^2)y] + 8a_{\mathrm{sym}}\beta\right\}, \quad (6)$$

where $x$ and $y$ are integers and $|x|^2 + |y|^2 \neq 0$ with $Z = (1-\beta)\xi/[(1-\beta)x + (1+\beta)y]$ and $N = (1+\beta)\xi/[(1-\beta)x + (1+\beta)y]$. Here only the differences of the




Dong_Zuo_Gu_Wang_Peng2010_PRC81-064309
Dong_Zuo_Scheid2011_PRL107-012501

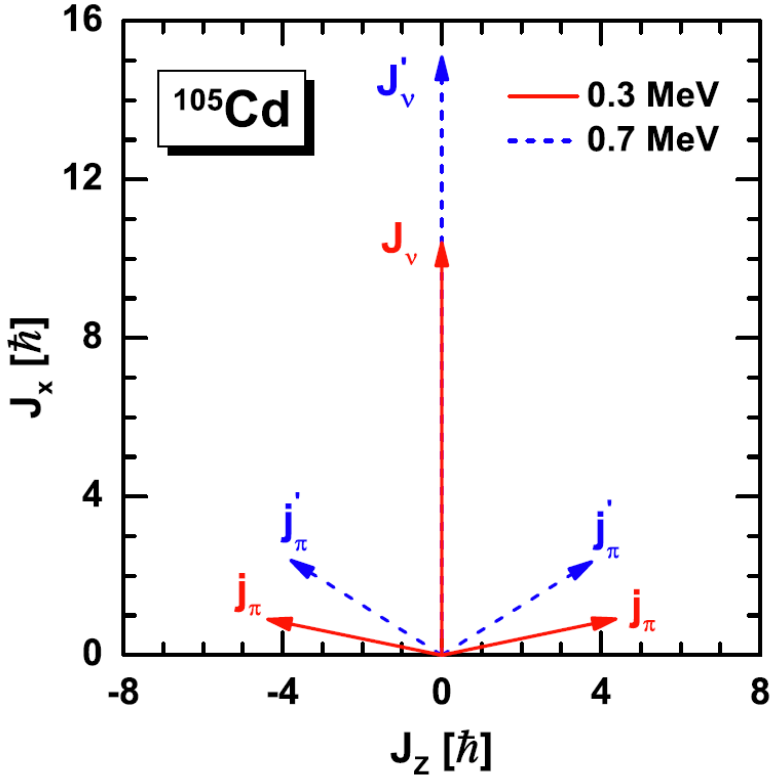
$\sqrt{\langle\sigma^2\rangle} = 0.077$ MeV

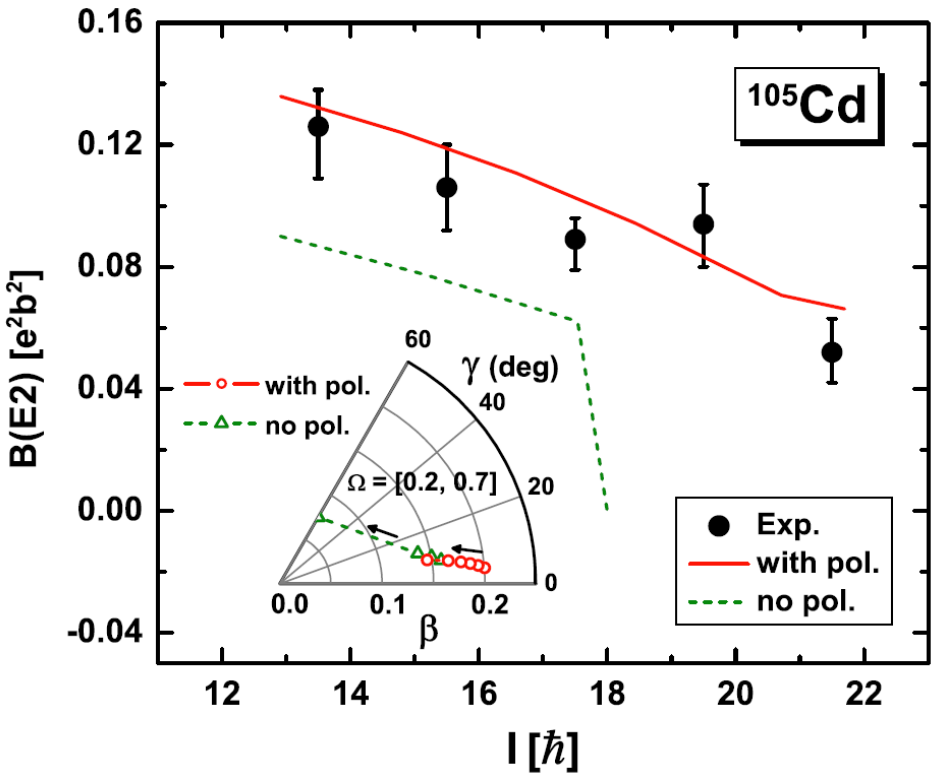
# Highlights: Antimagnetic rotation (AMR)

PRL 107, 122501 (2011) PHYSICAL REVIEW LETTERS week ending 16 SEPTEMBER 2011

## Antimagnetic Rotation Band in Nuclei: A Microscopic Description

P. W. Zhao (赵鹏巍),[1] J. Peng (彭婧),[2] H. Z. Liang (梁豪兆),[1] P. Ring,[1,3] and J. Meng (孟杰)[1,4,5]




Peng_Meng_Ring_Zhang2008_PRC78-024313
Zhao_Zhang_Peng_Liang_Ring_Meng2011_PLB699-181
Zhao_Peng_Liang_Ring_Meng2011_PRL105-122501

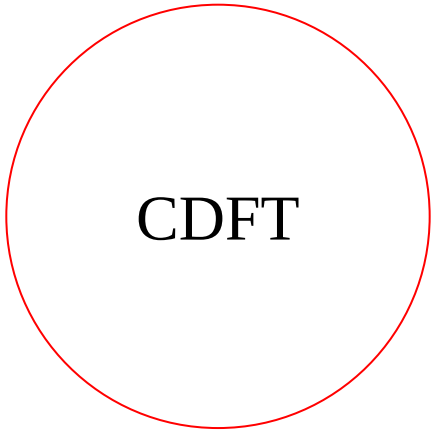
- Covariant density functional theory, tilted axis cranking
- First microscopic & self-consistent descrip.

# Development of theoretical models

- Shell models
  - No-core MCSM
  - Angular momentum projected SM
  - Cranked SM
- Density functional Theories
  - Skyrme, Gogny HF (HFB); +RPA; +Cranking
  - Covariant DFT
- Transport models
  - Macroscopic: Dinuclear system models; fluctuation-dissipation models
  - Microscopic: QMD; BUU; time-dep. HF
- Many others
  - Theory of reaction with unstable nuclei
  - Microscopic theory of alpha decay
  - Mass models or formulas
  - .....

# Covariant density functional theories

To include
more correlations




To be
more self-consistent

# Covariant density functional theories

**To include more correlations**

CDFT

**To be more self-consistent**

| **Continuum & resonances** |
| --- |
| RCHB / Def. RCHB |
| rBCS / Green's Func. |
| ACCC / CSM / RSM |

| **$\pi$ & Exchange (Fock) term** |
| --- |
| RHF |
| RHFB |
| Def. RHFB |

| **Magnetic moment** |
| --- |
| Odd-T component |
| Currents (1-$\pi$) |
| Configuration mixing |

# Covariant density functional theories

**Magnetic rot. & chirality**
RMF w/ γ
Configuration-fixed
Tilted axis cranking

**Low-*E* spec. & phase trans.**
RMF w/ γ
Angular momentum proj.
5-dim. Bohr Hamiltonian

**Giant/pygmy resonances**
RMF-RPA
RHF-RPA

**To include more correlations**

CDFT

**To be more self-consistent**

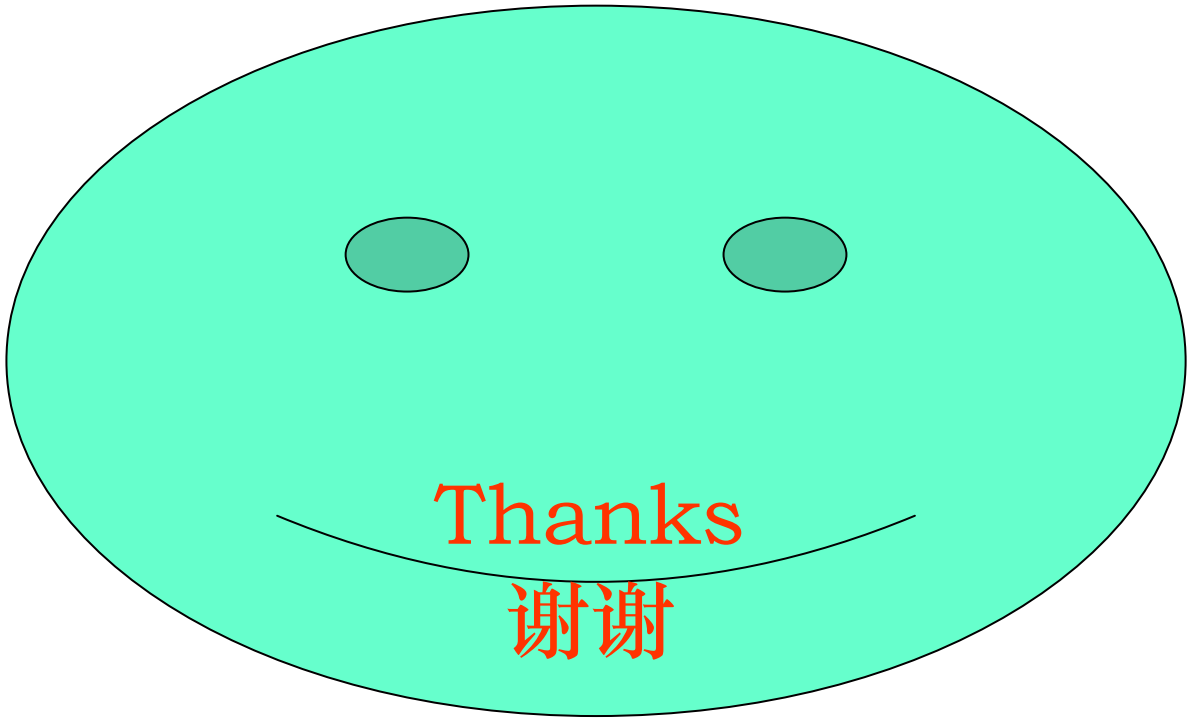
**Continuum & resonances**
RCHB / Def. RCHB
rBCS / Green's Func.
ACCC / CSM / RSM

**π & Exchange (Fock) term**
RHF
RHFB
Def. RHFB

**Magnetic moment**
Odd-T component
Currents (1-π)
Configuration mixing

Zhou, Shan-Gui
周　善　贵

ITP/CAS
Beijing

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