Invariant-mass spectroscopy of the neutron-rich oxygen and fluorine isotopes

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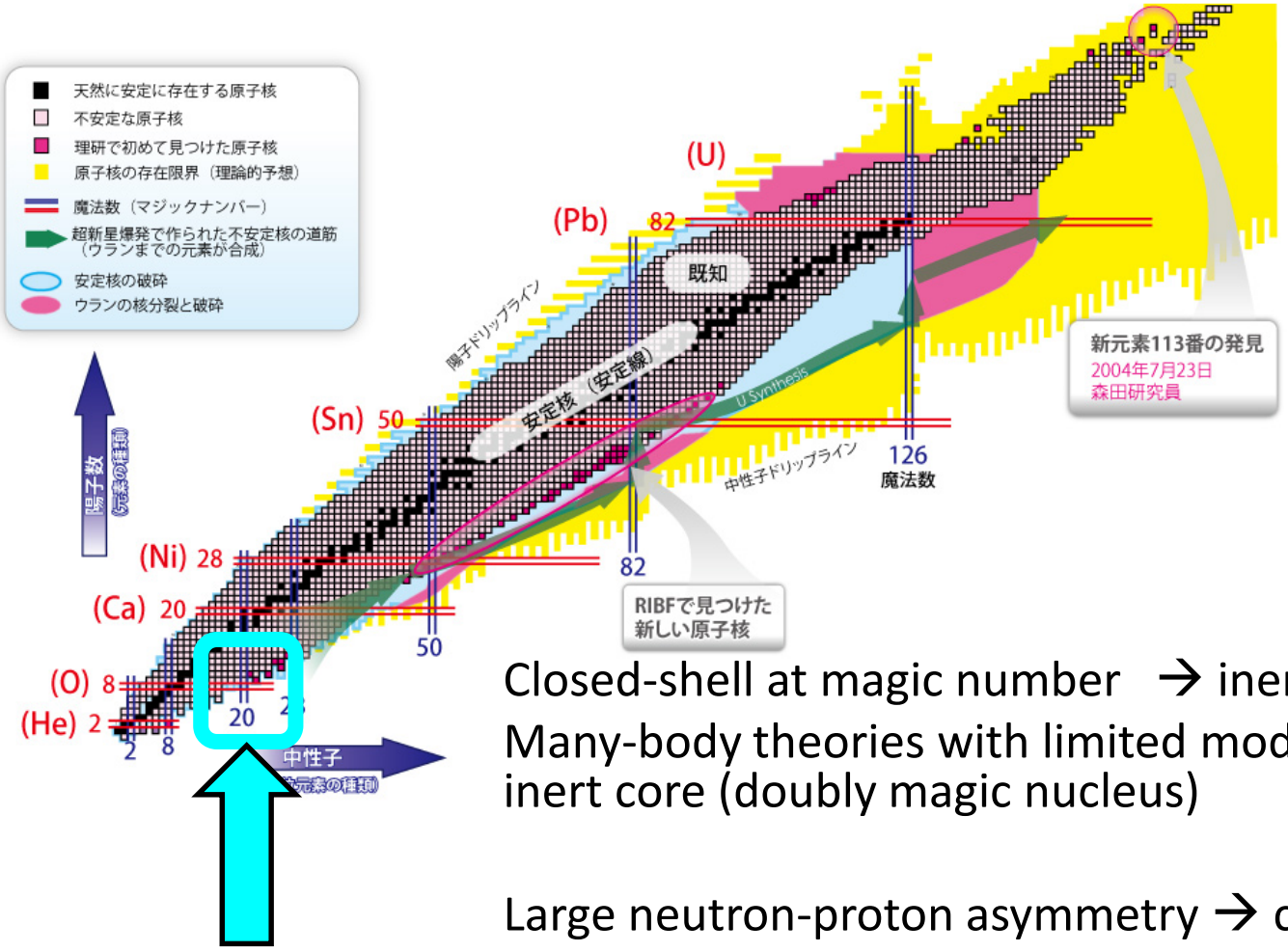
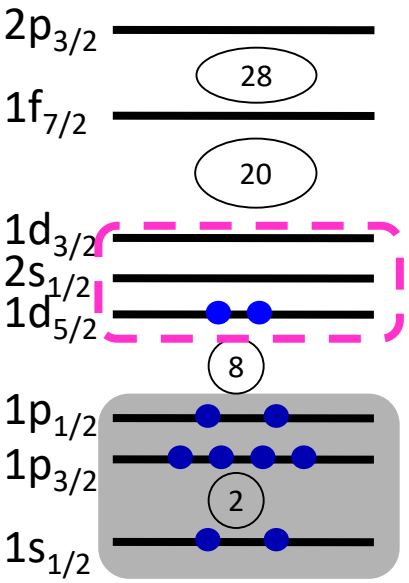
第4回クラスター階層領域研究会, 2020年5月28日　オンライン

Nucleus is many-body system of nucleons





Closed-shell at magic number → inert character

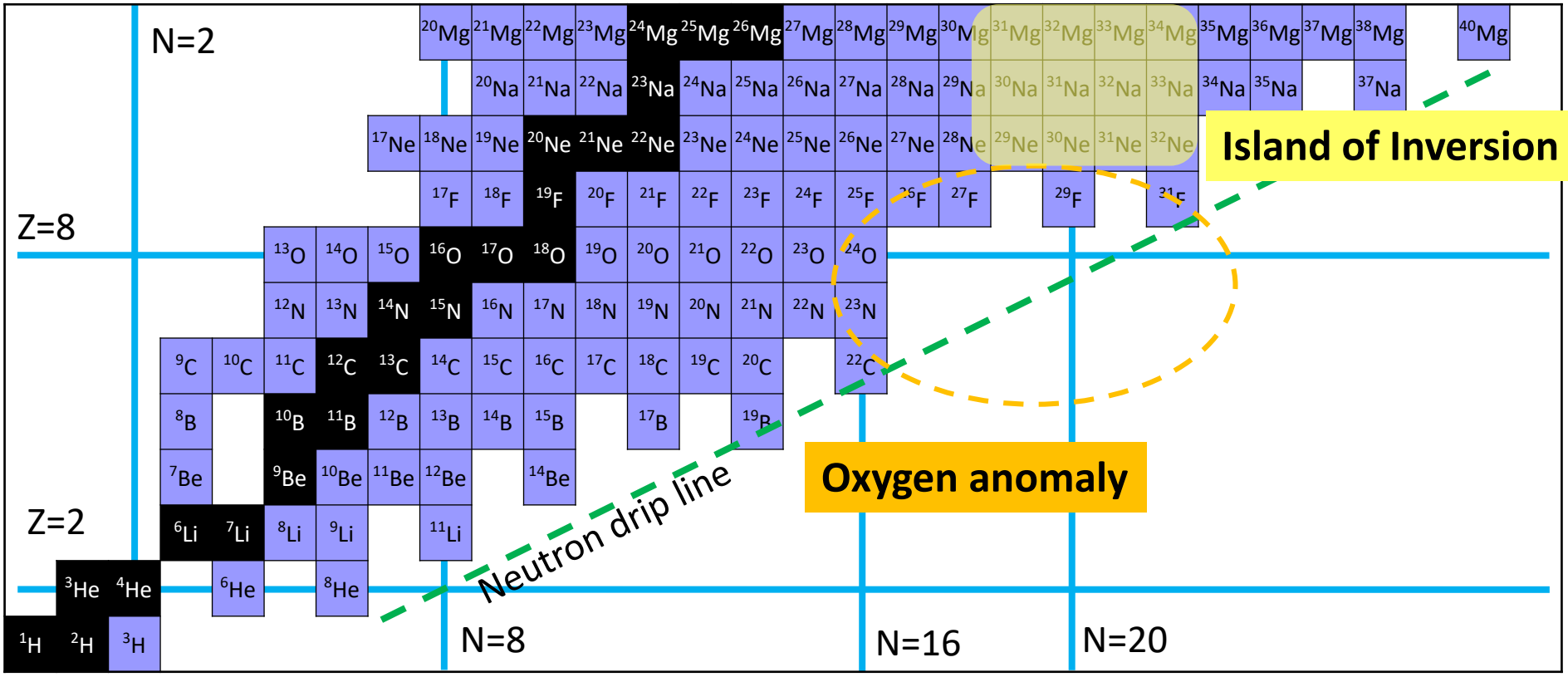
Many-body theories with limited model space by assuming inert core (doubly magic nucleus)

Large neutron-proton asymmetry → change of shell structure

^{78}Ni, ^{132}Sn are doubly magic with conventional magic numbers among unstable nuclei

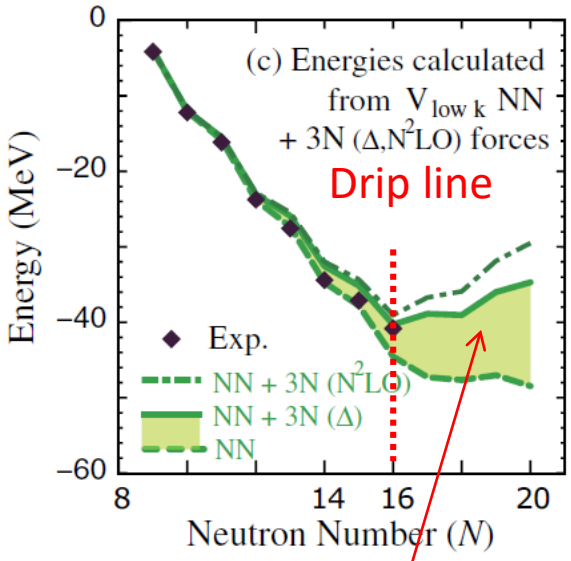
https://www.nishina.riken.jp/researcher/archive/illust.html

Physics topics



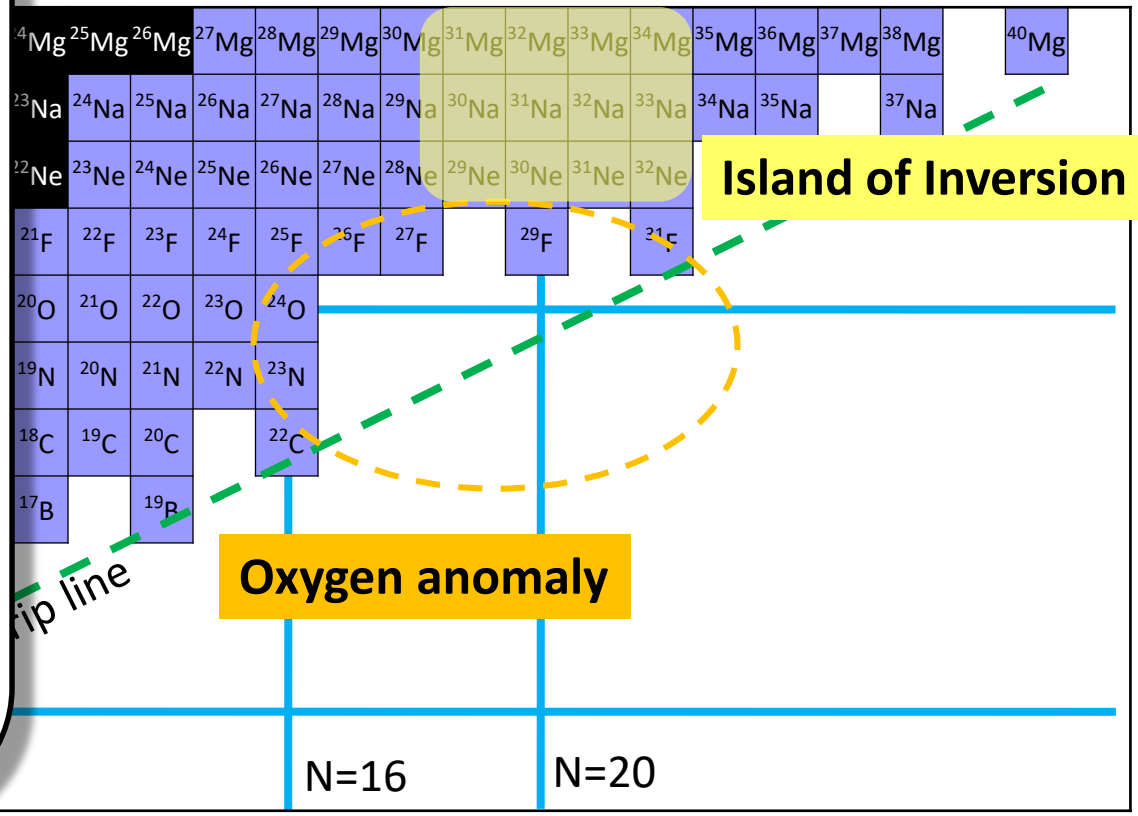
- Sudden change of neutron drip line (Oxygen anomaly)
  - What is the origin?
- Island of inversion
  - Where is the south boundary?

T. Otsuka et al., PRL105, 032501 (2010)



Large effect at N>16

3NF plays an important role in binding of oxygens



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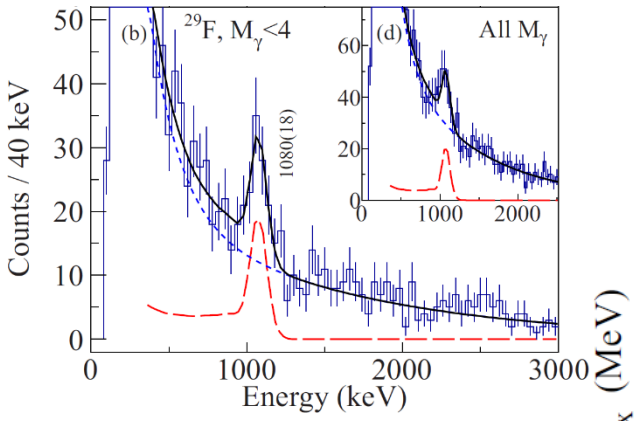
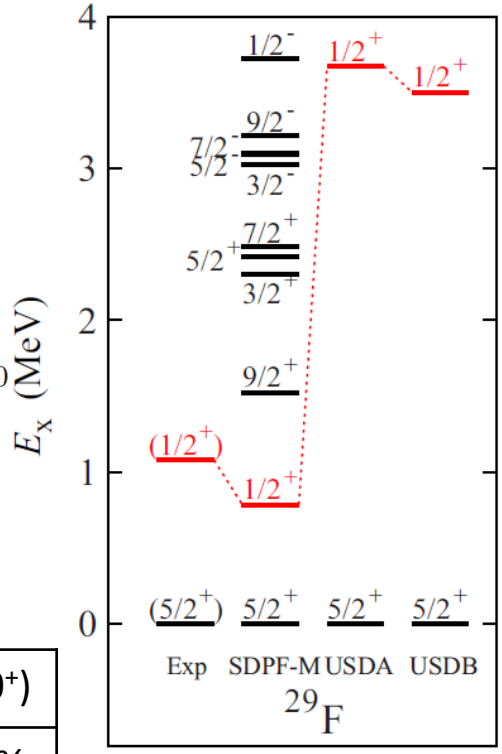
Physics topics

P. Doornenbal, Y.K et al., PRC95, 041301(R), (2017)





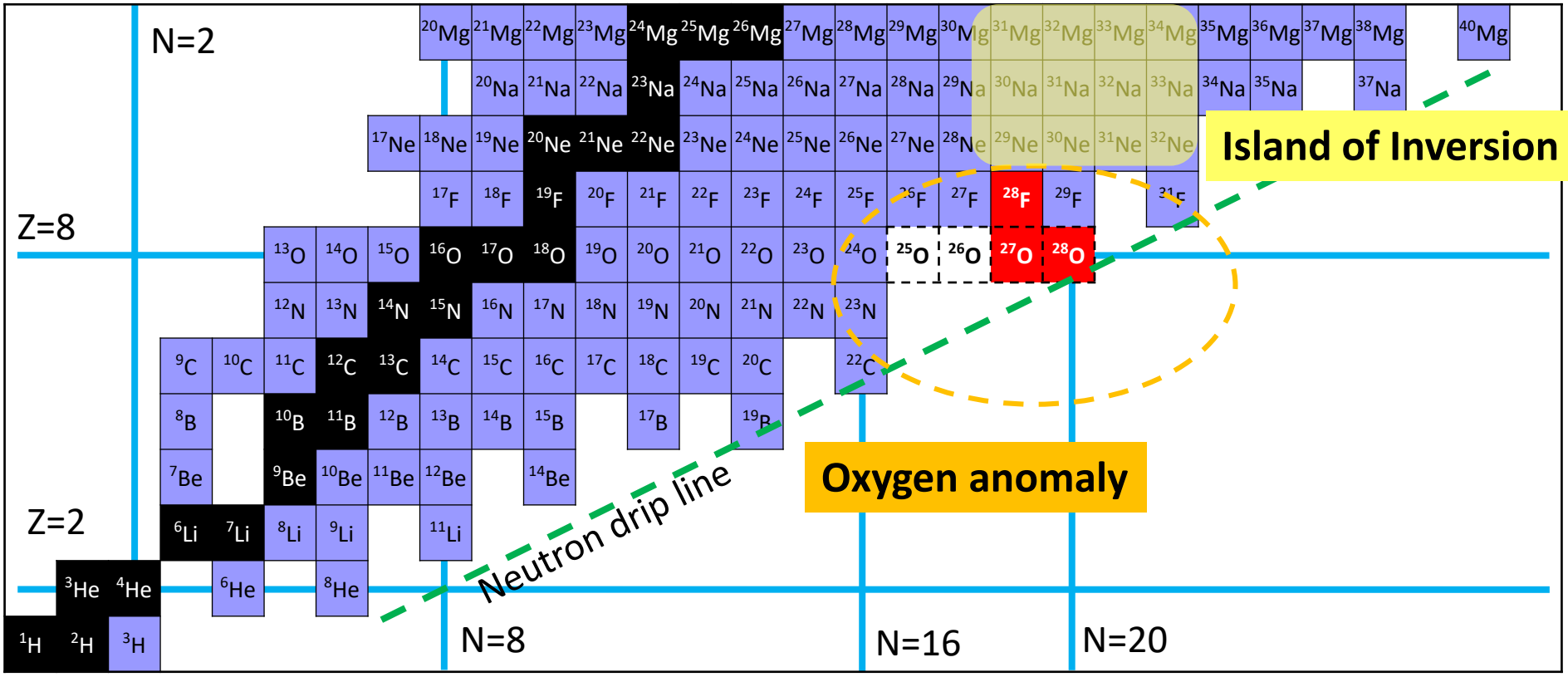
SDPF-M shell model calculation predicts small 0p0h prob. for ^{29}F and ^{28}O

^{29}F(5/2$^+$)	^{29}F(1/2$^+$)	^{28}O(0$^+$)
7.9%	1.0%	10.9%

(Oxygen anomaly)

- Island of inversion
  - Where is the south boundary?

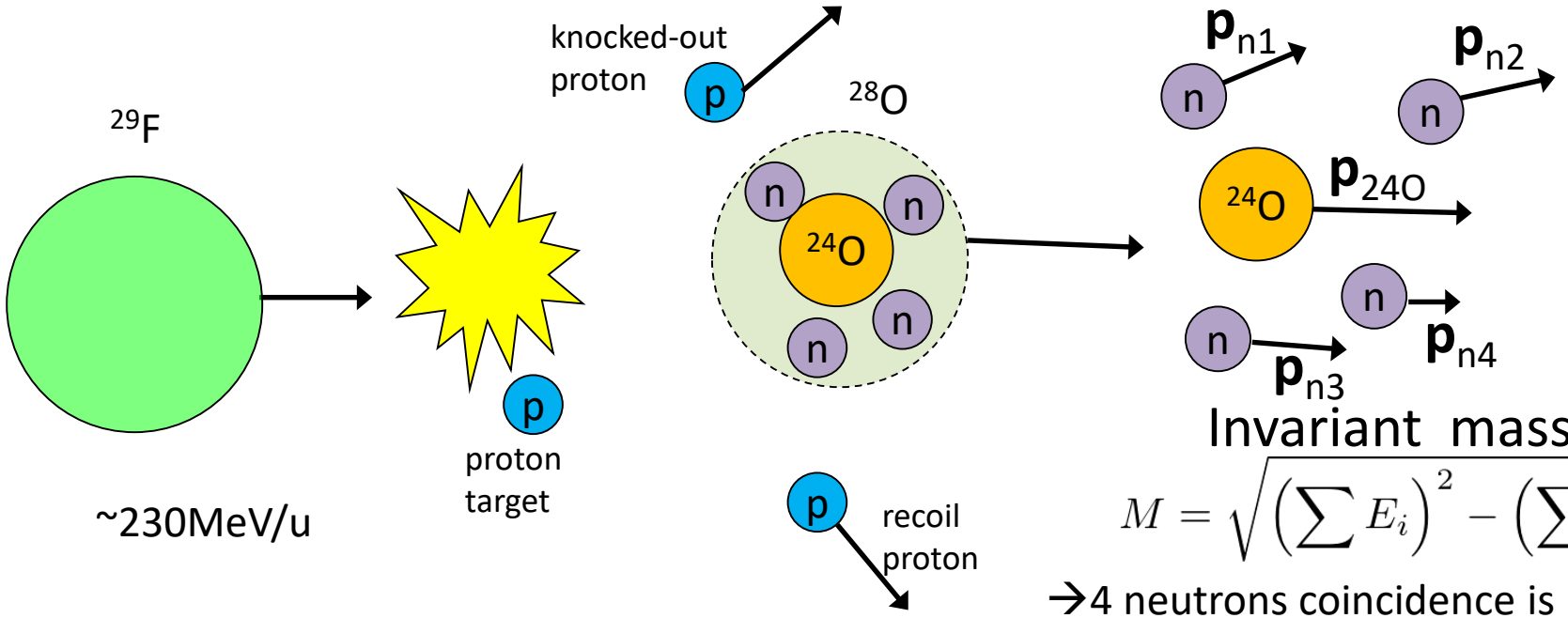
Experimental study of unbound oxygen isotopes



Invariant-mass spectroscopy of ^{27}O, ^{28}O, ^{28}F

Invariant mass method

^{28}O: One-proton removal reaction of ^{29}F

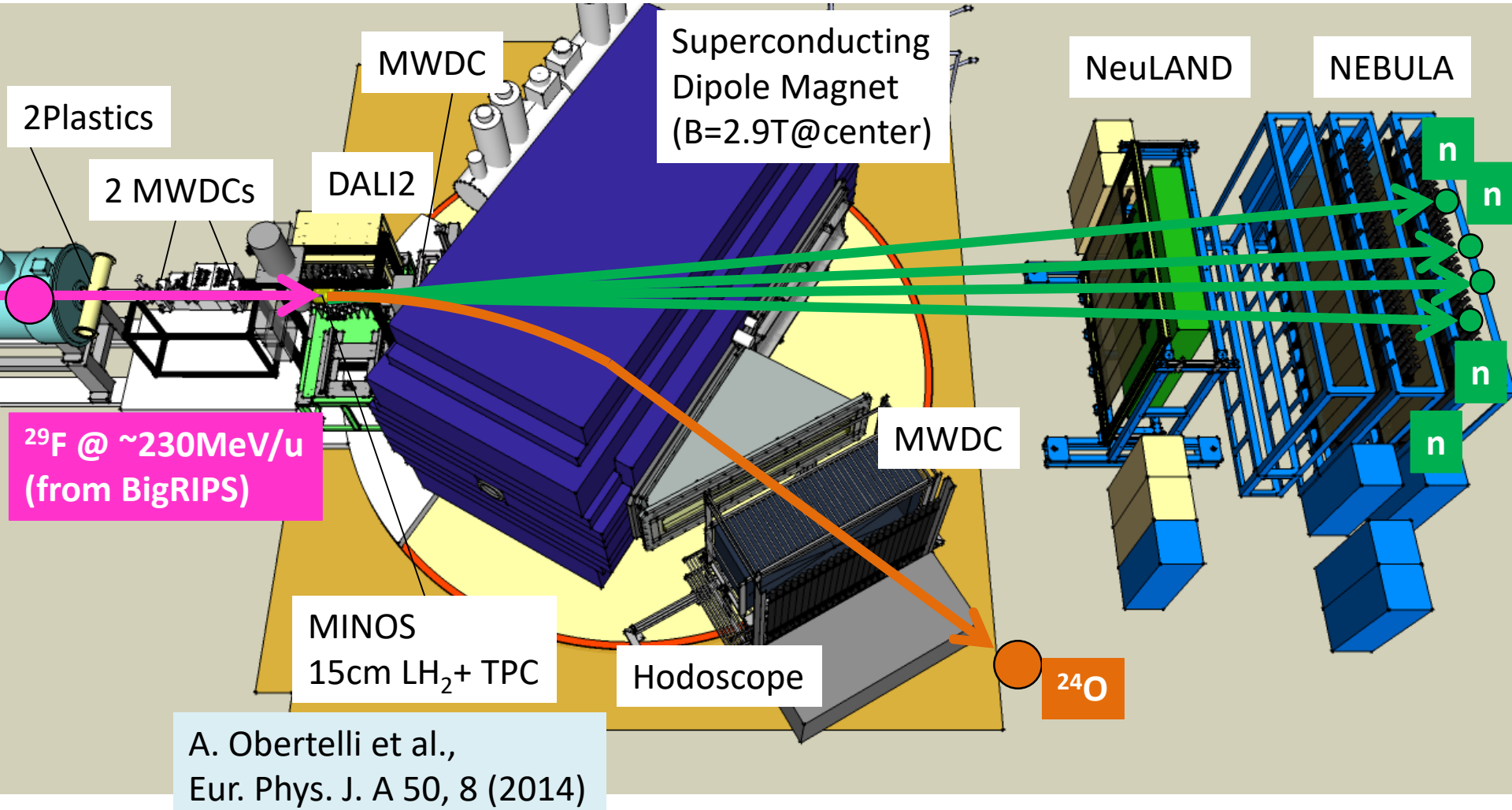


^{27}O: Two-proton removal reaction of ^{29}Ne
-1n1p reaction from ^{29}F

^{28}F: one-proton removal reaction of ^{29}Ne
one-neutron removal reaction of ^{29}F

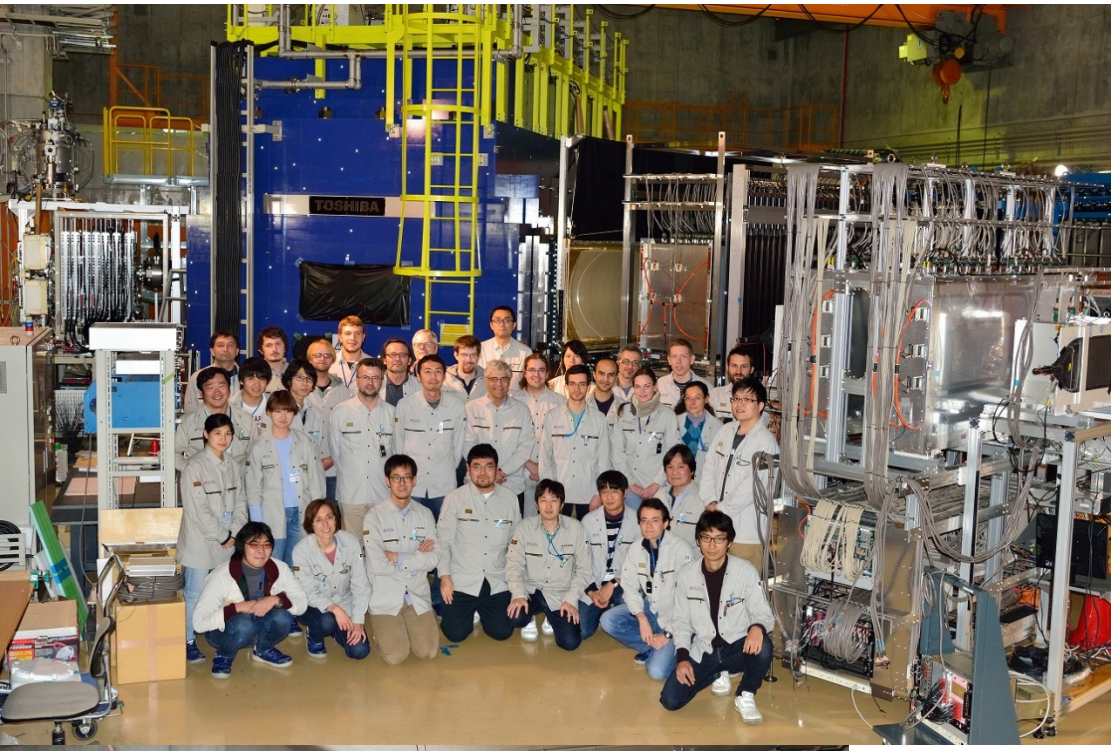
^{28}O measurement @ RIBF-SAMURAI

T. Kobayashi et al., NIMB317, 294, (2013)



A. Obertelli et al.,
Eur. Phys. J. A 50, 8 (2014)

SAMURAI21 collaboration



Y.Kondo, T.Nakamura, N.L.Achouri, H.Al Falou, L.Atar, T.Aumann, H.Baba, K.Boretzky, C.Caesar, D.Calvet, H.Chae, N.Chiga, A.Corsi, H.L.Crawford, F.Delaunay, A.Delbart, Q.Deshayes, Zs.Dombrádi, C.Douma, Z.Elekes, P.Fallon, I.Gašparić, J.-M.Gheller, J.Gibelin, A.Gillibert, M.N.Harakeh, A.Hirayama, C.R.Hoffman, M.Holl, A.Horvat, Á.Horváth, J.W.Hwang, T.Isobe, J.Kahlbow, N.Kalantar-Nayestanaki, S.Kawase, S.Kim, K.Kisamori, T.Kobayashi, D.Körper, S.Koyama, I.Kuti, V.Lapoux, S.Lindberg, F.M.Marqués, S.Masuoka, J.Mayer, K.Miki, T.Murakami, M.A.Najafi, K.Nakano, N.Nakatsuka, T.Nilsson, A.Obertelli, F.de Oliveira Santos, N.A.Orr, H.Otsu, T.Ozaki, V.Panin, S.Paschalis, A.Revel, D.Rossi, A.T.Saito, T.Saito, M.Sasano, H.Sato, Y.Satou, H.Scheit, F.Schindler, P.Schrock, M.Shikata, Y.Shimizu, H.Simon, D.Sohler, O.Sorlin, L.Stuhl, S.Takeuchi, M.Tanaka, M.Thoennessen, H.Törnqvist, Y.Togano, T.Tomai, J.Tscheuschner, J.Tsubota, T.Uesaka, H.Wang, Z.Yang, M. Yasuda, K.Yoneda

Tokyo Tech, Argonne, ATOMKI, CEA Saclay, Chalmers, CNS, Cologne, Eotvos, GANIL, GSI, IBS, KVI-CART, Kyoto Univ., Kyushu Univ., LBNL, Lebanese-French University of Technology and Applied Science, LPC-CAEN, MSU, Osaka Univ., RIKEN, Ruđer Bošković Institute, SNU, Tohoku Univ., TU Darmstadt, Univ. of Tokyo

Experimental results

PHYSICAL REVIEW LETTERS **124,** 152502 (2020)

Extending the Southern Shore of the Island of Inversion to ^{28}F

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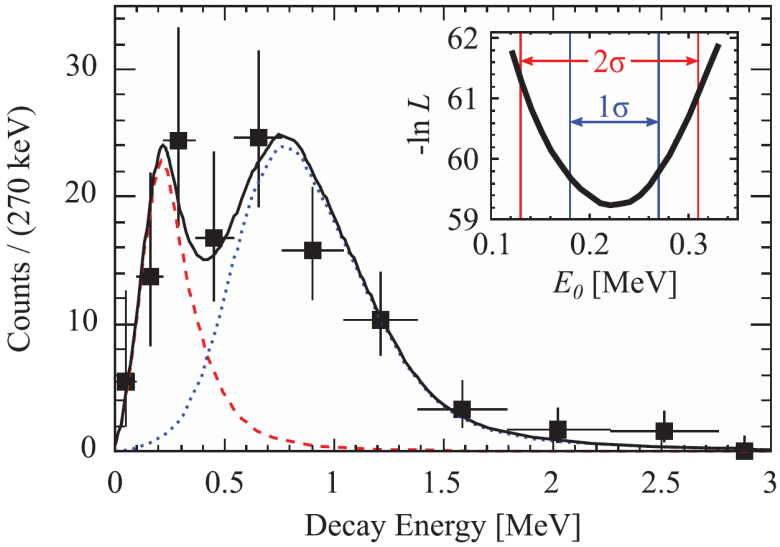
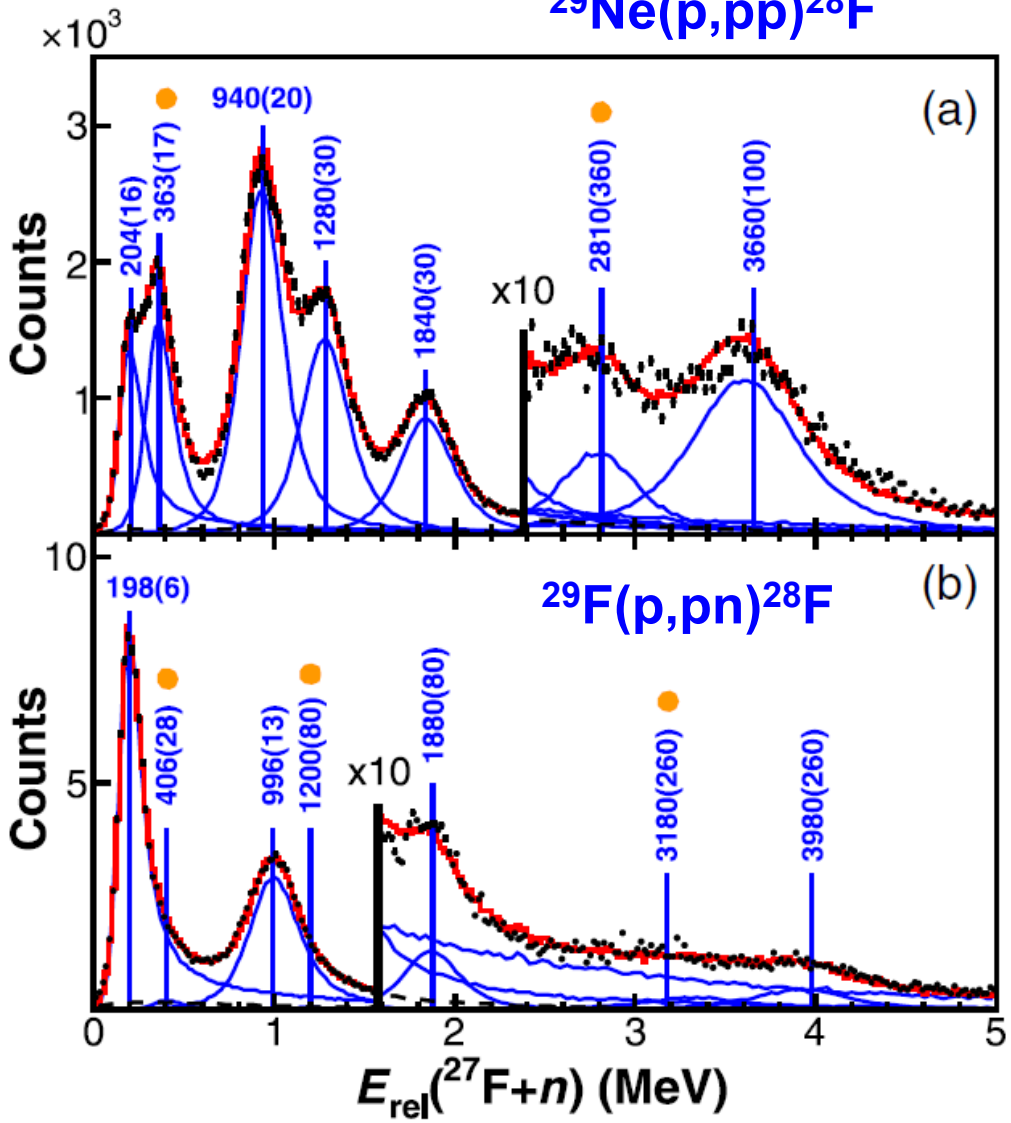
(SAMURAI21 collaboration)

Results of ^{28}F

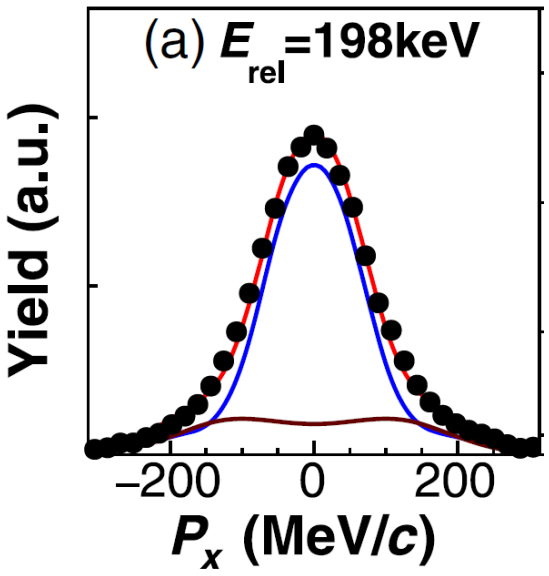
First measurement for ^{28}F
G. Christian et al.
PRC85, 034327 (2012)

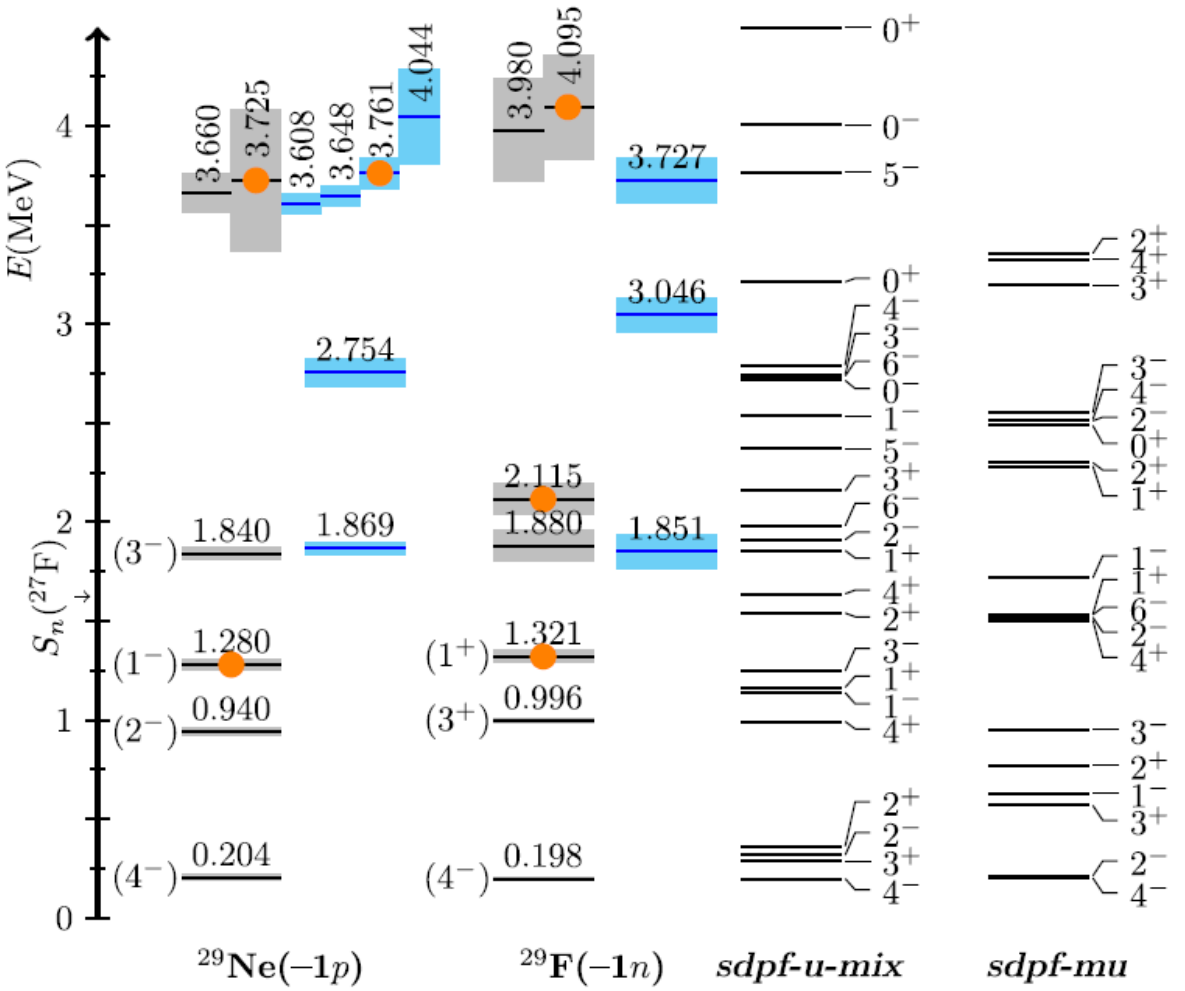




Results of ^{28}F

→g.s of ^{28}F:
p-wave neutron
Intruder state!





^{28}F is included in the island of inversion

Summary

Invariant mass spectroscopy of ^{27}O, ^{28}O, ^{28}F

- ^{28}F
  - p-wave ground state → Island of inversion
- ^{27}O
  - Resonance state at 1.1MeV
    - Sequential decay through ^{26}O ground state
- ^{28}O
  - ~100 events of ^{24}O + 4n coincidence