JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

Shape-coexistence near-mid shell nucleus ^{190}Pb studied in in-beam experiments

Presenter Joonas Ojala

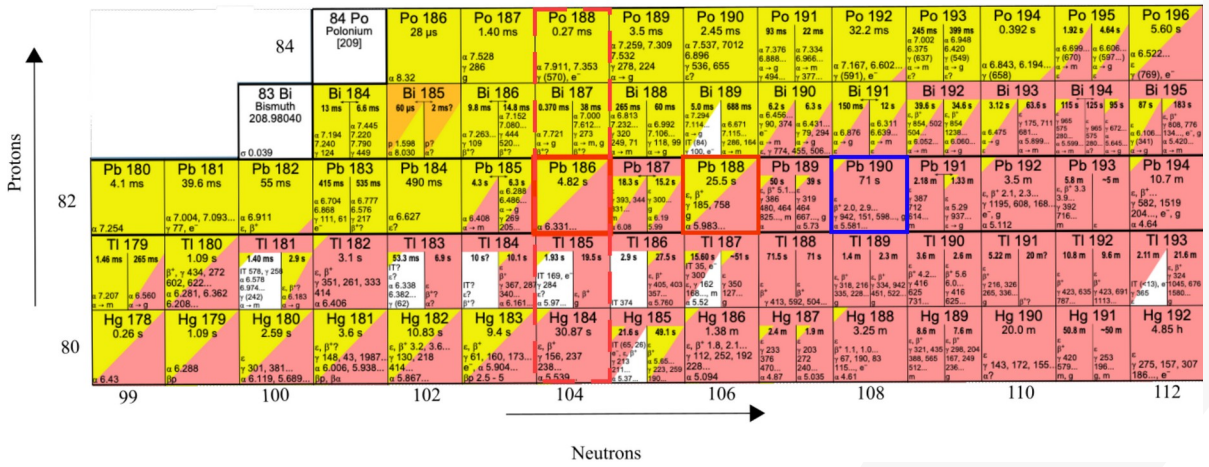
On behalf of the JR161 and S24 collaboration

Content

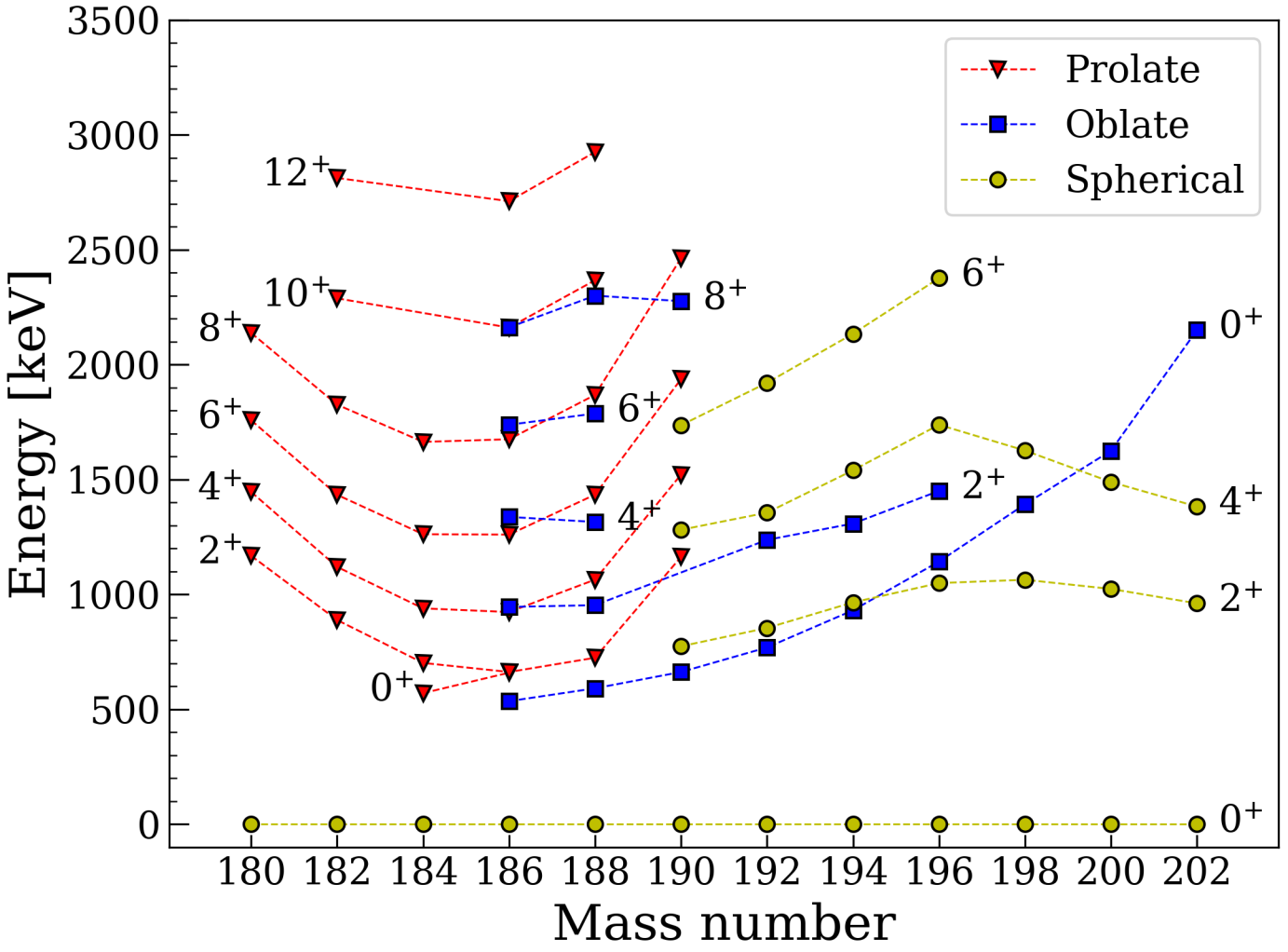
- Introduction to topic
- Overview of experimental setups
- Results for the neutron-deficient Pb region
- Experimental results on ^{190}Pb
- Future

Shape coexistence in neutron-deficient Pb isotopes

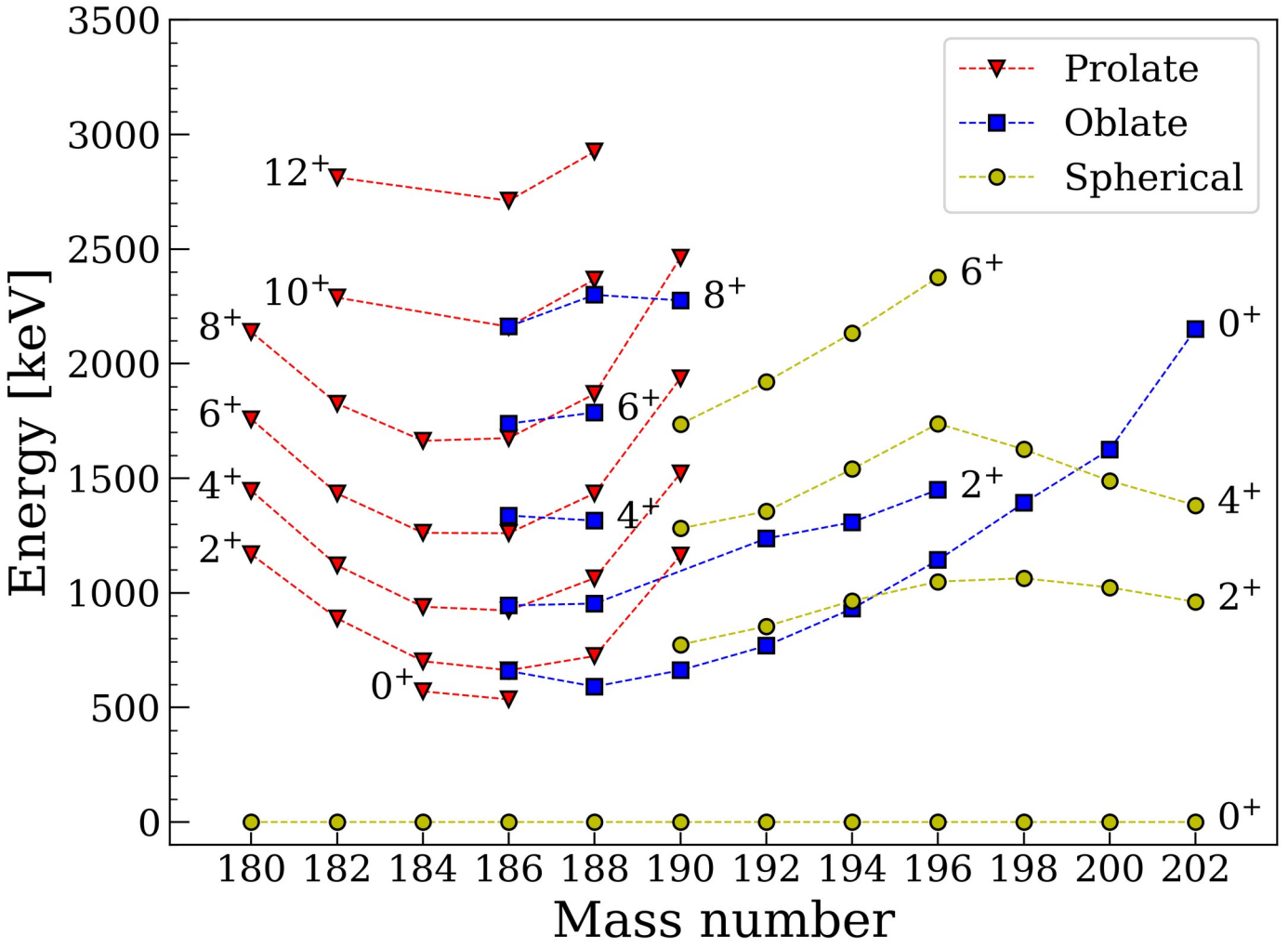
- The shape coexistence phenomenon has been under study for several decades in Pb region
- Shape coexistence appears close to the neutron-midshell $N \approx 104$
- In addition to the spherical ground state, the intruder structures have been identified to be as following shapes, prolate π(4p-4h) and oblate π(2p-2h), in neutron-deficient Pb isotopes



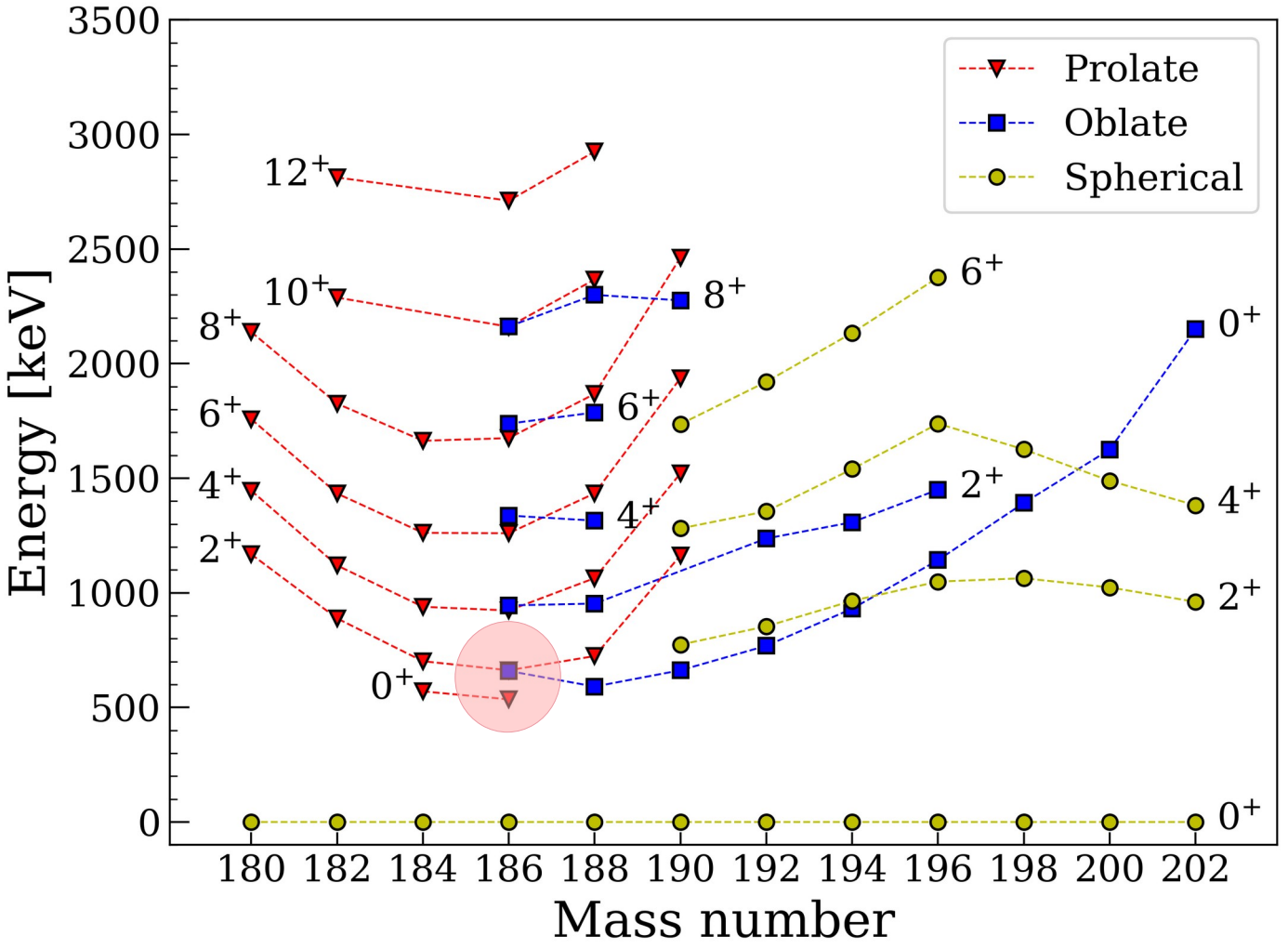
The interpretation of level energy systematics of Pb isotopes before 2021



SAGE experiment: Pb-186



SAGE experiment: Pb-186



SAGE experiment: Pb-186

communications physics

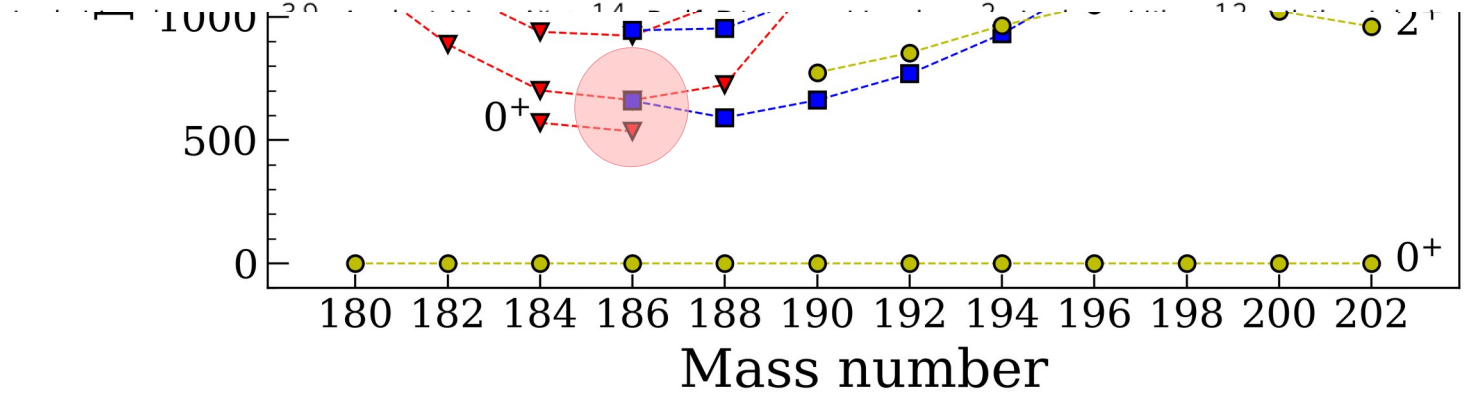
ARTICLE

https://doi.org/10.1038/s42005-022-00990-4 OPEN

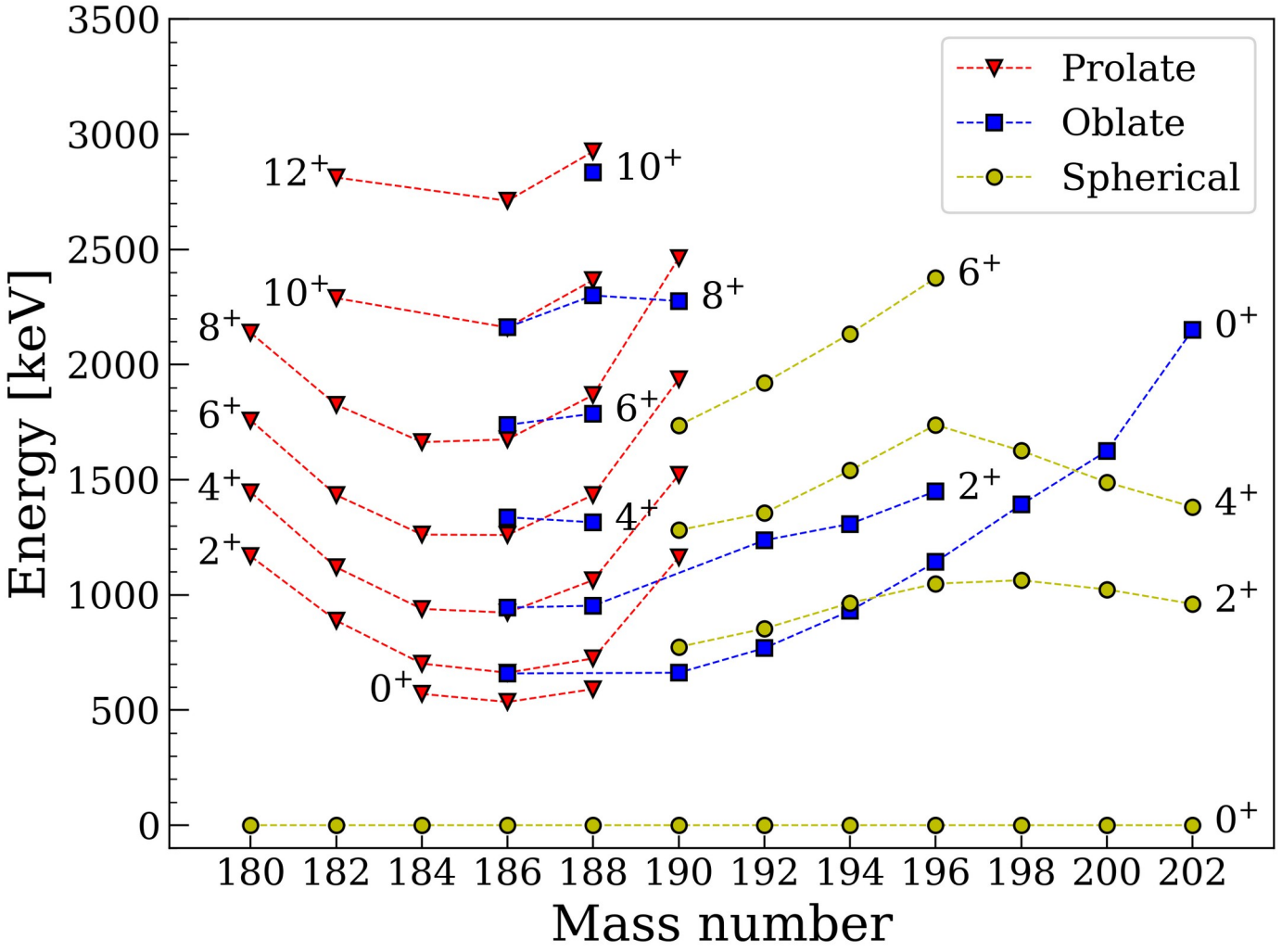
Check for updates

Reassigning the shapes of the 0^+ states in the ^{186}Pb nucleus

Joonas Ojala[1], Janne Pakarinen[1✉], Philippos Papadakis[1,6], Juha Sorri[1,7], Mikael Sandzelius[1], Daniel M. Cox[1,2,8], Kalle Auranen[1], Hussam Badran[1], Paul J. Davies[3], Tuomas Grahn[1], Paul T. Greenlees[1],



SAGE experiment: Pb-188



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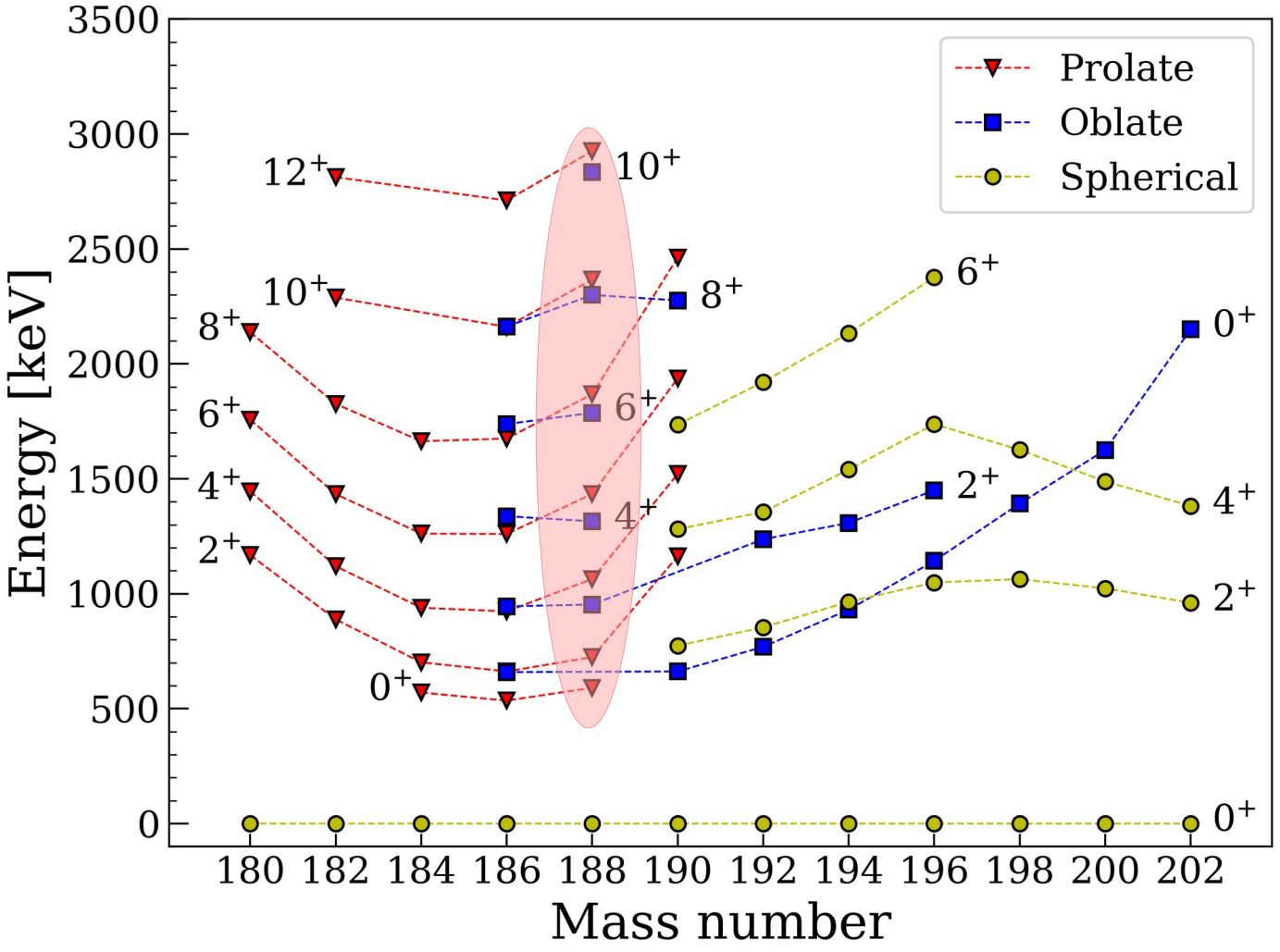
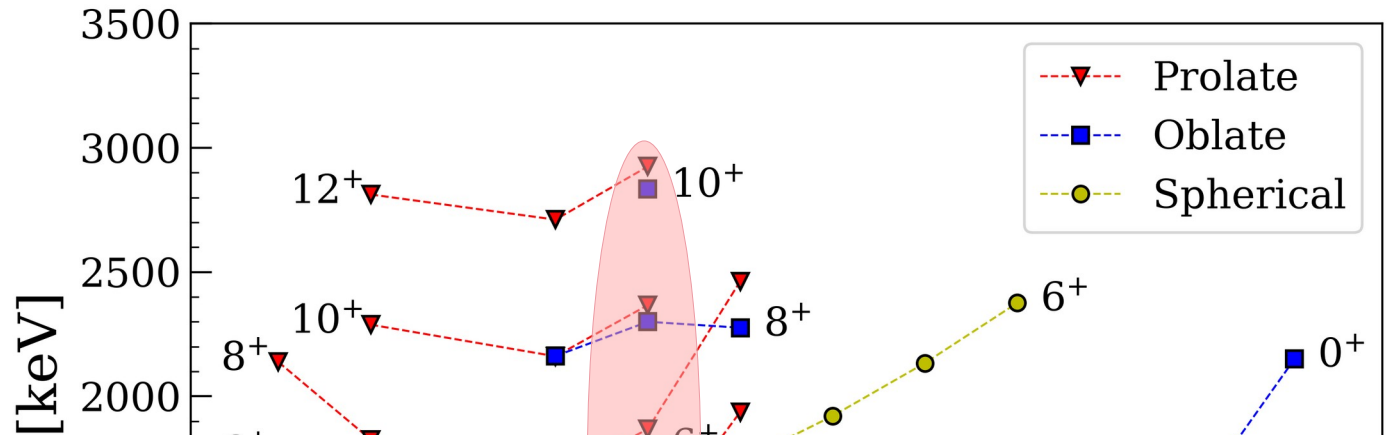


SAGE experiment: Pb-188



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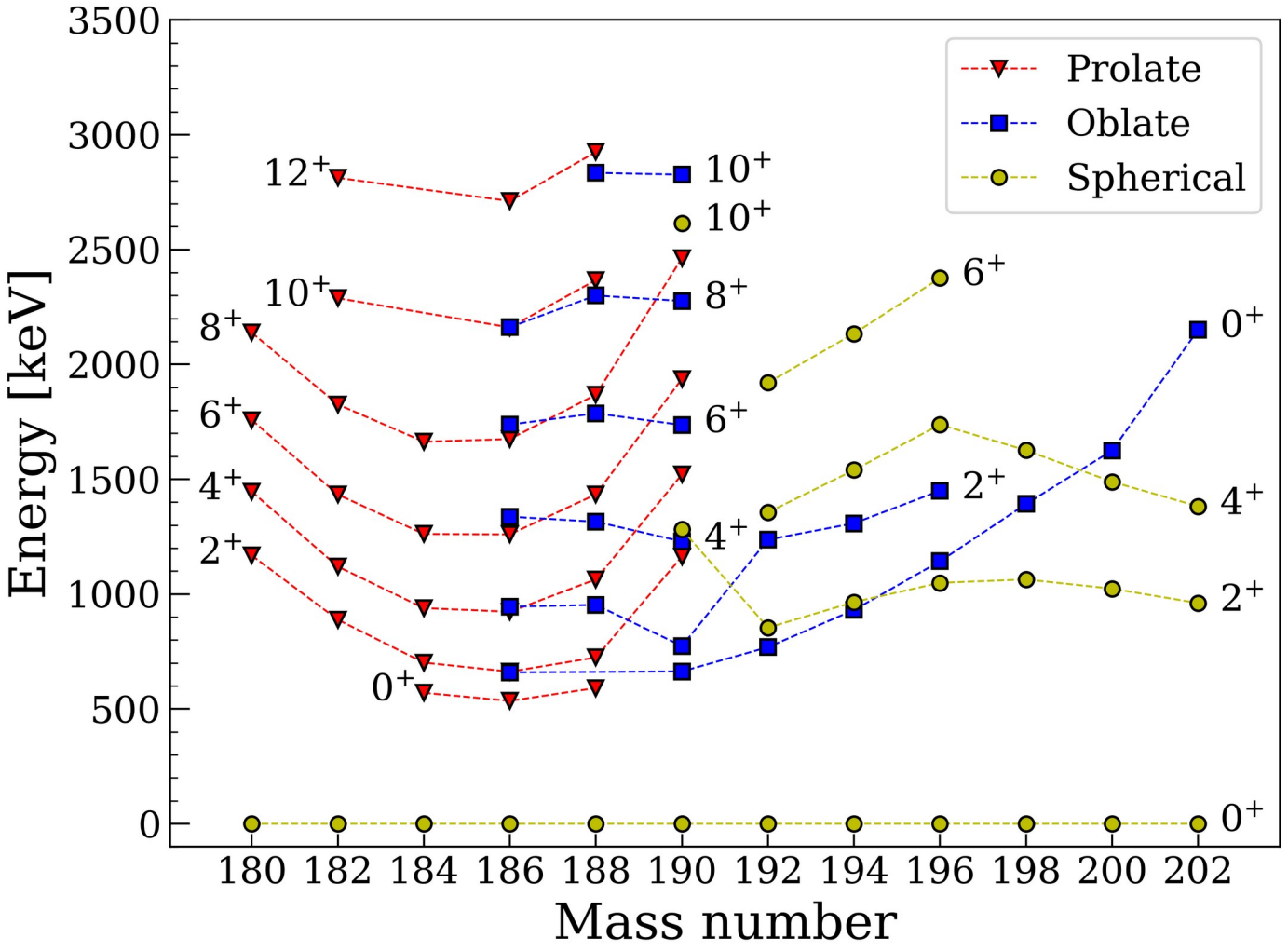
Letter

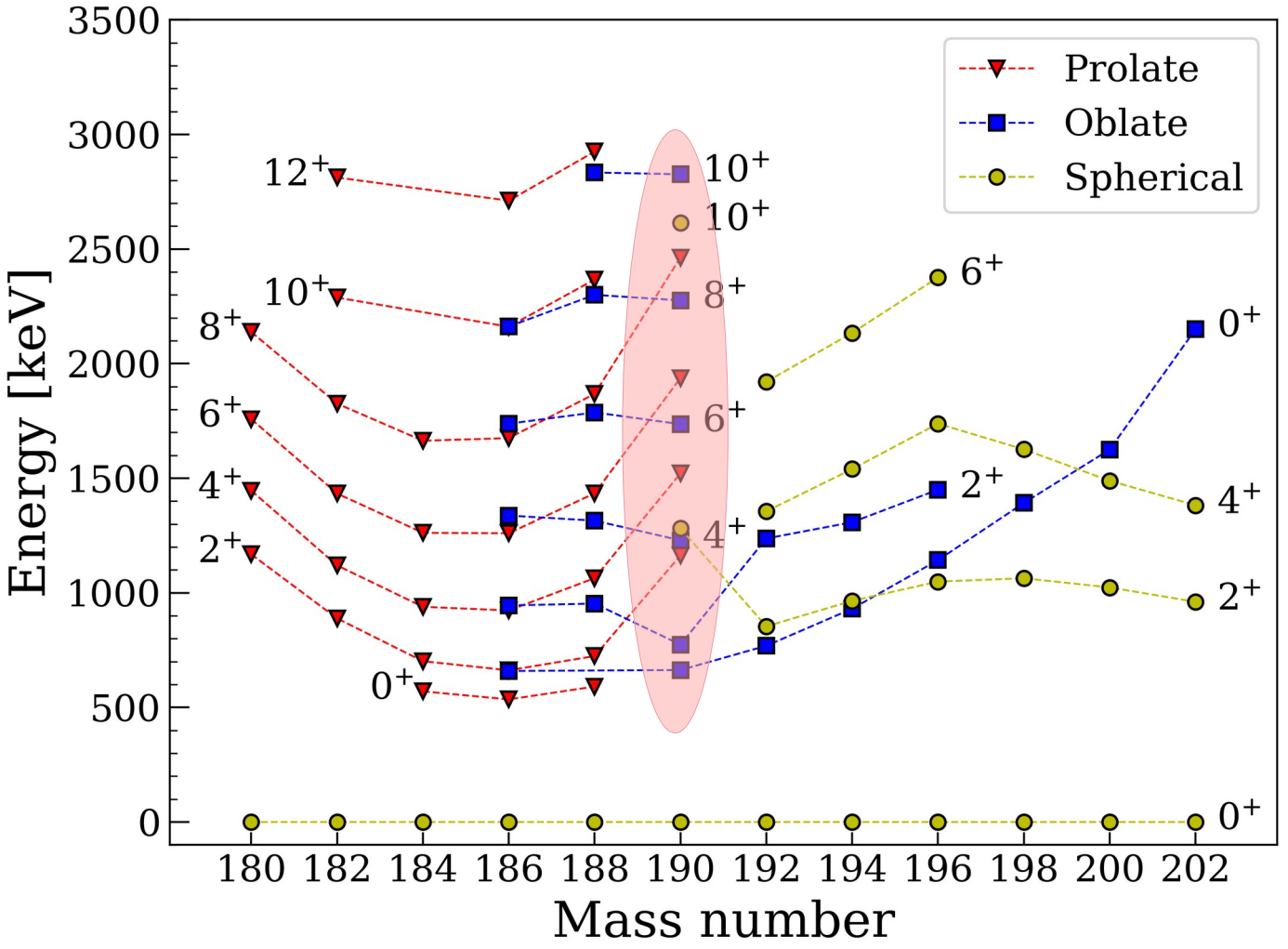
Direct observation of $E0$ transitions in ^{188}Pb through in-beam spectroscopy

P. Papadakis [a,b,*,1], J. Pakarinen [a,**], A.D. Briscoe [a,2], D.M. Cox [a], R. Julin [a], K. Auranen [a], T. Grahn [a], P.T. Greenlees [a], K. Hadyńska-Klek [c], A. Herzáň [a,d], R.-D. Herzberg [e], U. Jakobsson [a,3],

SAGE / APPA experiment: Pb-190



SAGE / APPA experiment: Pb-190



SAGE / APPA experiment: Pb-190

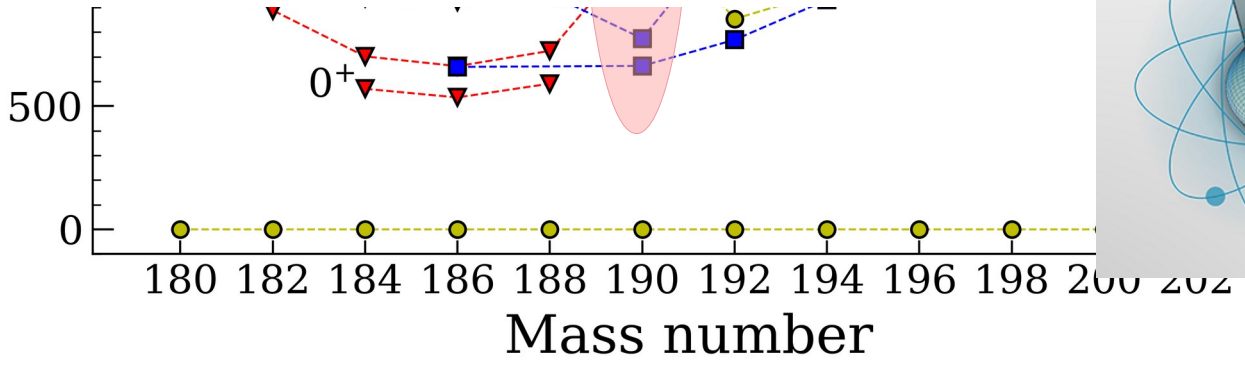
communications physics

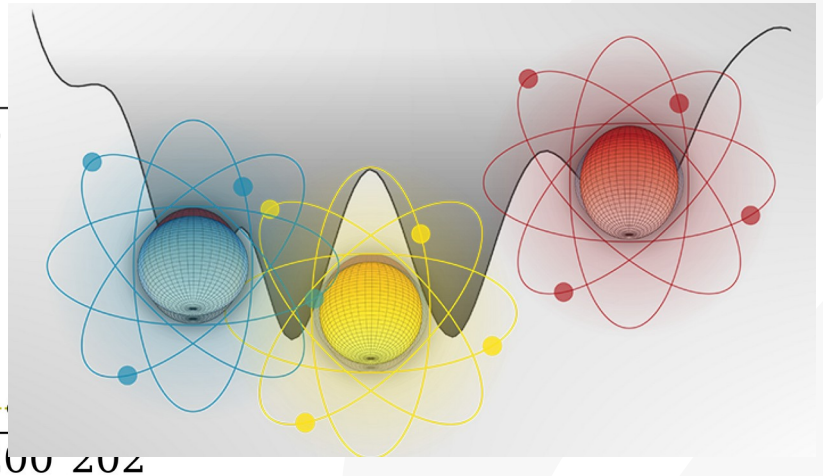
Article

https://doi.org/10.1038/s42005-024-01928-8

Direct measurement of three different deformations near the ground state in an atomic nucleus

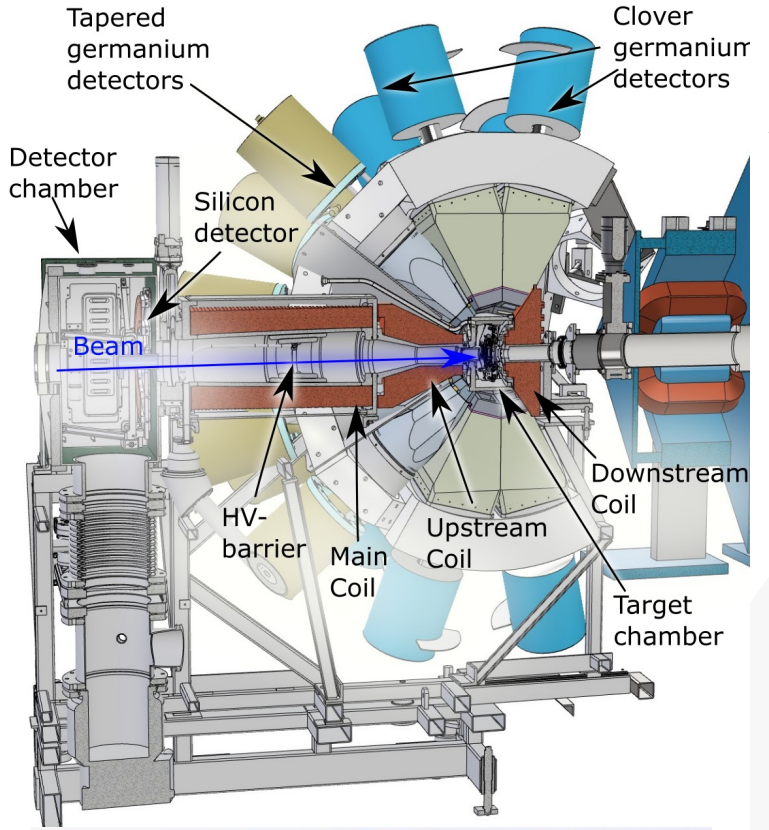
Adrian Montes Plaza [1,2], Janne Pakarinen [2] ✉, Philippos Papadakis [3], Rolf-Dietmar Herzberg [1], Rauno Julin[2], Tomás R. Rodríguez [4], Andrew D. Briscoe[2,11], Andrés Illana [2,4], Joonas Ojala [2],

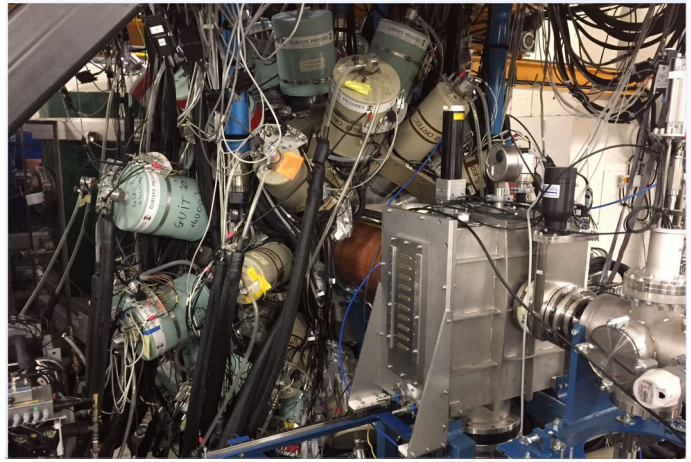




Simultaneous γ-ray and conversion-electron experiment: Pb-190

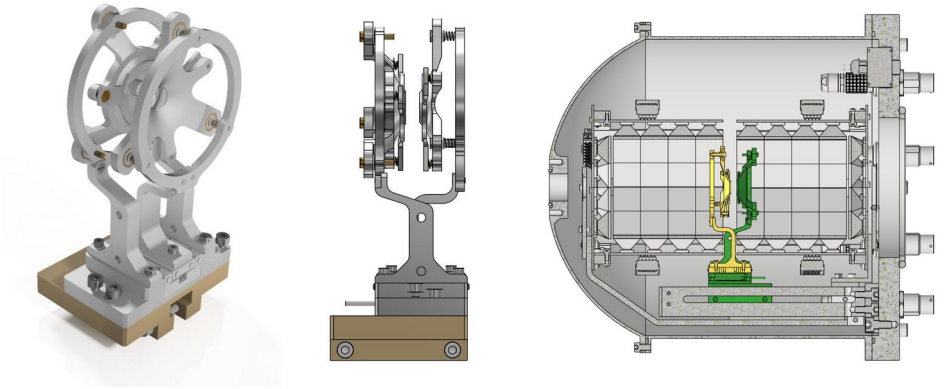
- Combined gamma-ray and conversion electron in-beam spectroscopy (SAGE)
  - 10 Tapered and 24 Clover type germanium detectors
  - The SAGE silicon detector is positioned upstream of the target
  - Conversion electrons are transported using the solenoid magnets from the target to the silicon detector
- $^{159}Tb(^{35}Cl,4n)^{190}Pb$ reaction
- The fusion-evaporation products were separated from beam using the MARA separator

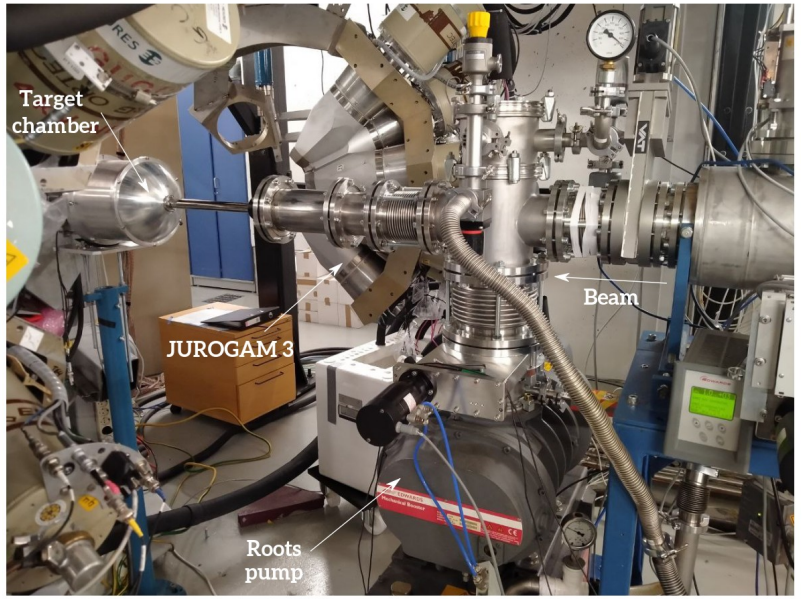




Lifetime experiment: Pb-190

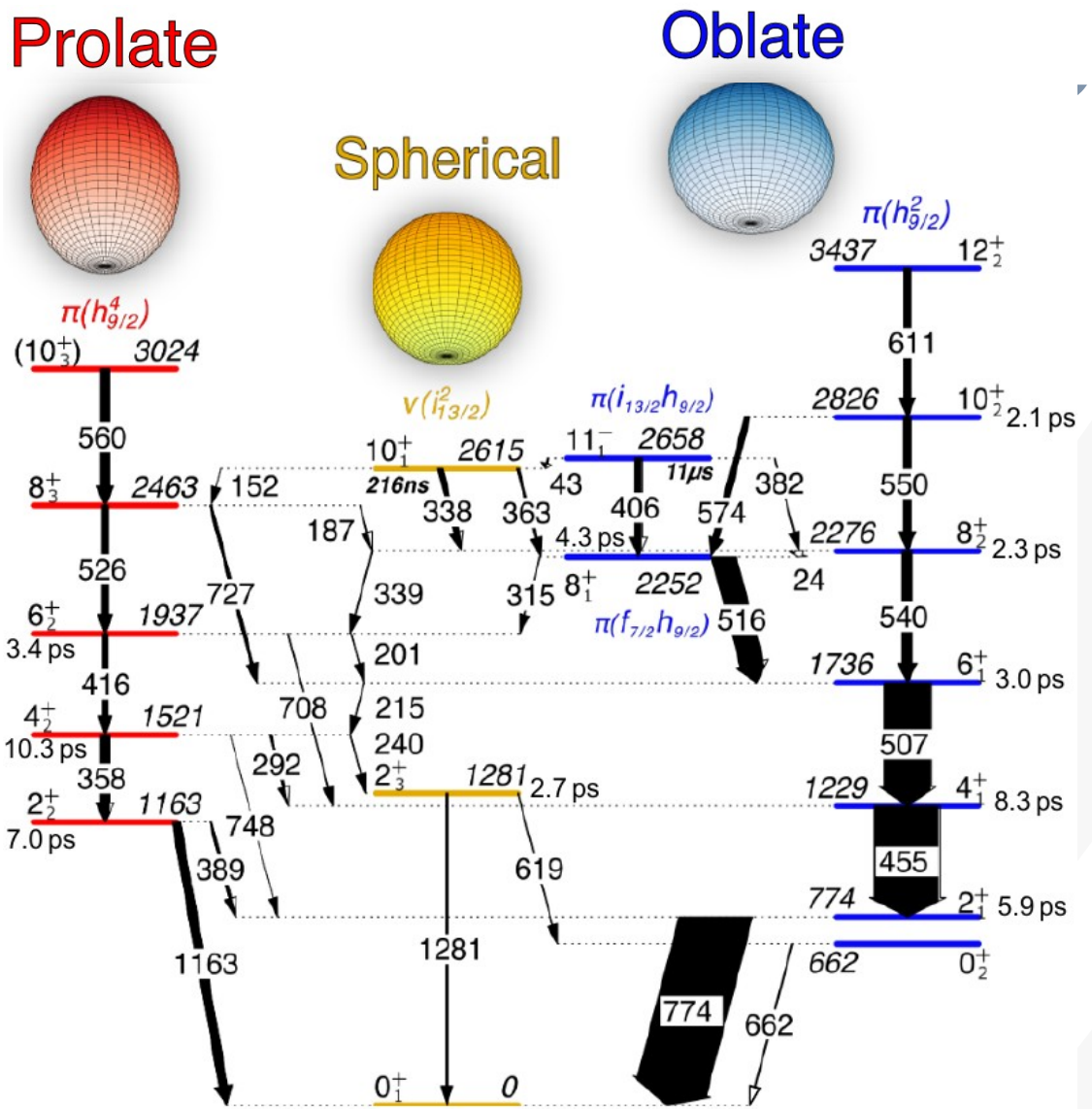
- Advanced Plunger-Particle detector Array (APPA)
  - Is used in conjunction of the Jurogam3 spectrometer (only 15 tapered germanium detectors were employed in this experiment)
  - Can be combined with JYUTube charged-particle detector array (Not used in this experiment)
- $^{108}Pd(^{86}Kr,4n)^{190}Pb$ reaction
- The fusion-evaporation products were separated from beam using the RITU separator



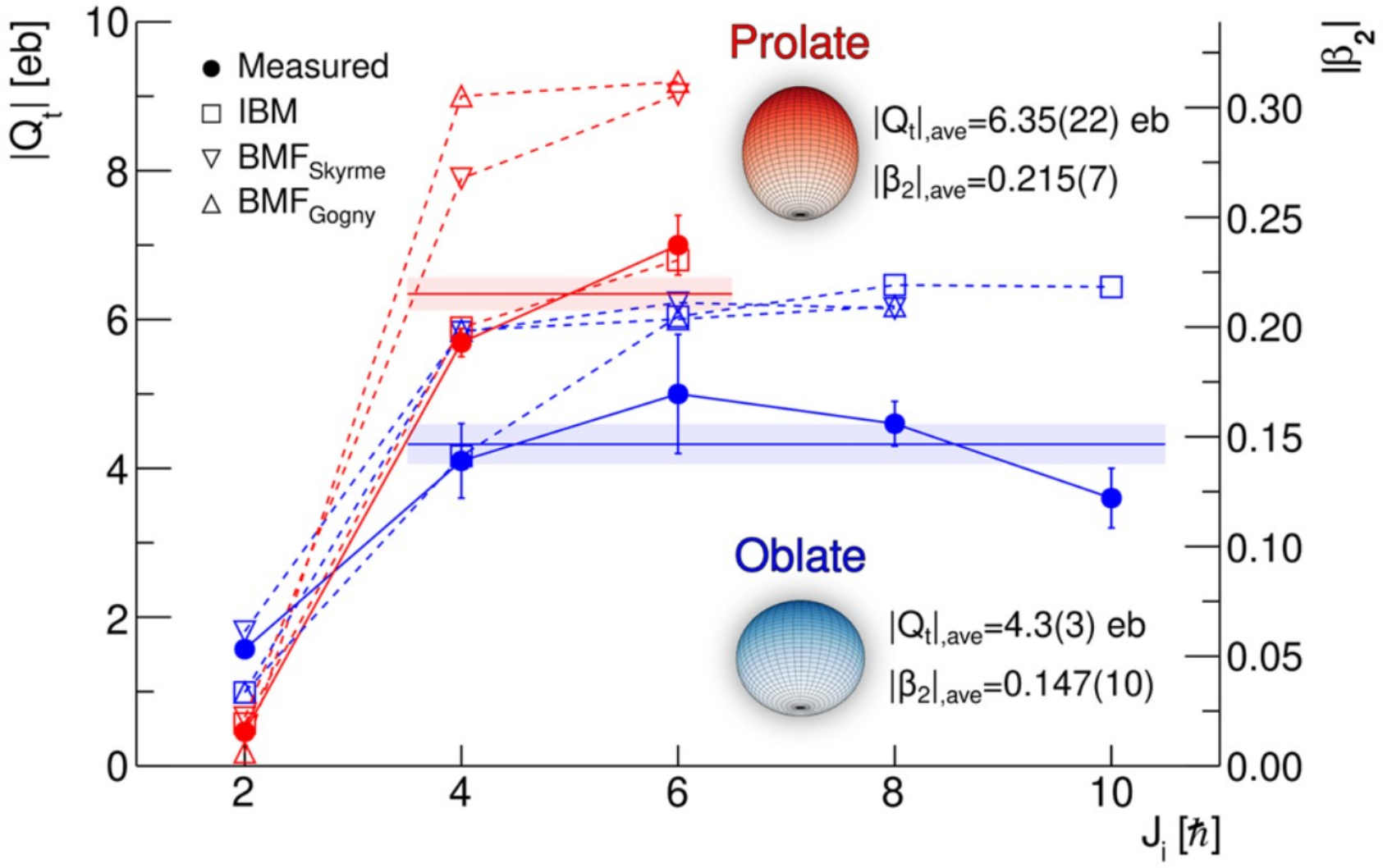


Results

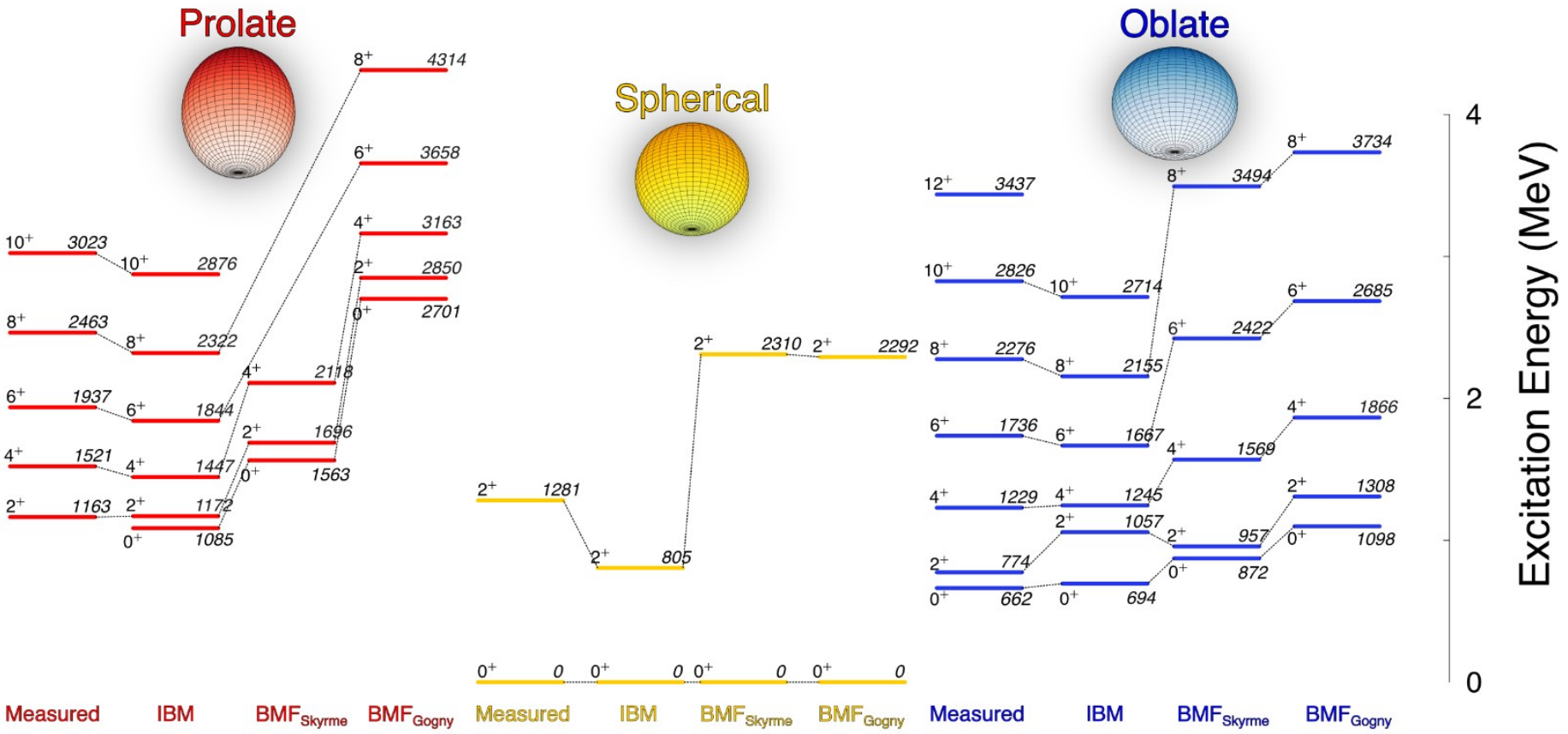
- The yrast band was associated with predominantly oblate shape
- The non-yrast band has been assigned a predominantly prolate character
- The measurement of E0($0_2^+ \rightarrow 0_1^+$) allowed to assign first excited 0^+ state to oblate band
- Discovery of a spherical 2_3^+ state



Results


Measured
IBM
BMF$_{Skyrme}$
BMF$_{Gogny}$
Prolate
$|Q_t|_{,ave}$=6.35(22) eb
$|\beta_2|_{,ave}$=0.215(7)
Oblate
$|Q_t|_{,ave}$=4.3(3) eb
$|\beta_2|_{,ave}$=0.147(10)
$|Q_t|$ [eb]
$|\beta_2|$
J_i [$\hbar$]
0
2
4
6
8
10
0.00
0.05
0.10
0.15
0.20
0.25
0.30

Results


Prolate
Spherical
Oblate
Measured
IBM
BMF$_{Skyrme}$
BMF$_{Gogny}$
Excitation Energy (MeV)
0
2
4

Future

Competing structures in the beyond neutron N=104 midshell nucleus ^{184}Pb

J. Ojala[a], J. Pakarinen[a,*], R. Wadsworth[b], H. Badran[a], D.M. Cox[a], A.D. Briscoe[c], A. Brown[b], T. Calverley[a,c], T. Grahn[a], P.T. Greenlees[a], J. Hilton[a,c], R. Julin[a], J. Konki[a], R. Llewellyn[b], S. Juutinen[a], M. Leino[a], P. Papadakis[a], J. Partanen[a,**], P. Rahkila[a], M. Sandzelius[a], J. Sarén[a], C. Scholey[a], S. Stoltze[a], J. Uusitalo[a], B. Wallis[b]

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Stay tuned!

JYVÄSKYLÄN YLIOPISTO
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THANK YOU!