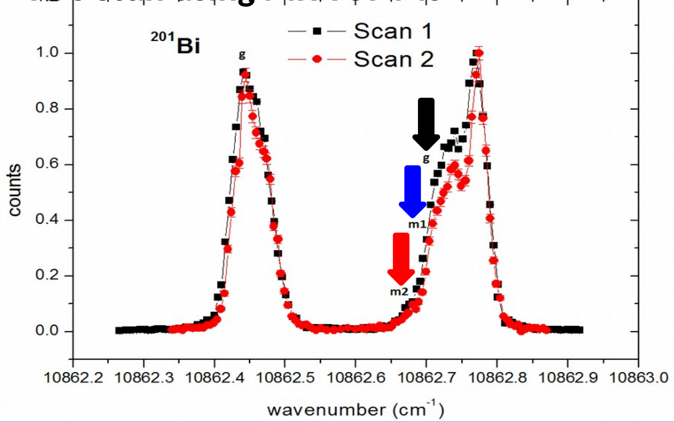
Collinear Laser Spectroscopy of Bismuth at COLLAPS- The complementarity of optical and non-optical laser spectroscopy techniques.

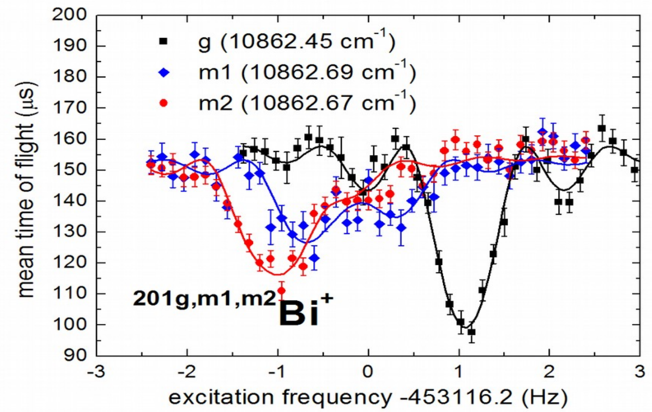
M. L. Bissell

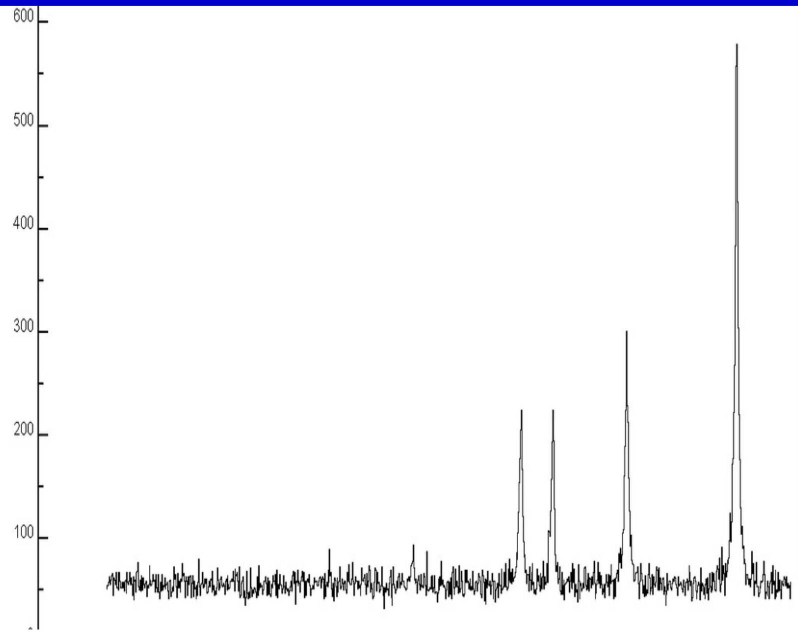
On behalf of COLLAPS, in collaboration with IS606

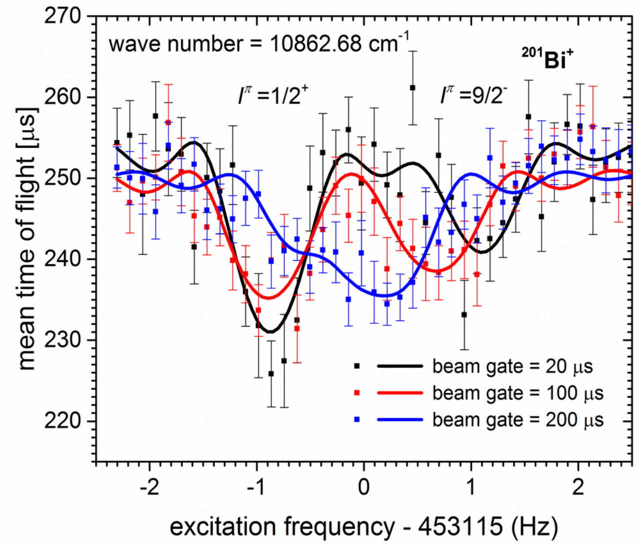
Laser Spectroscopy of Bi

HFS scan using MR-TOF MS





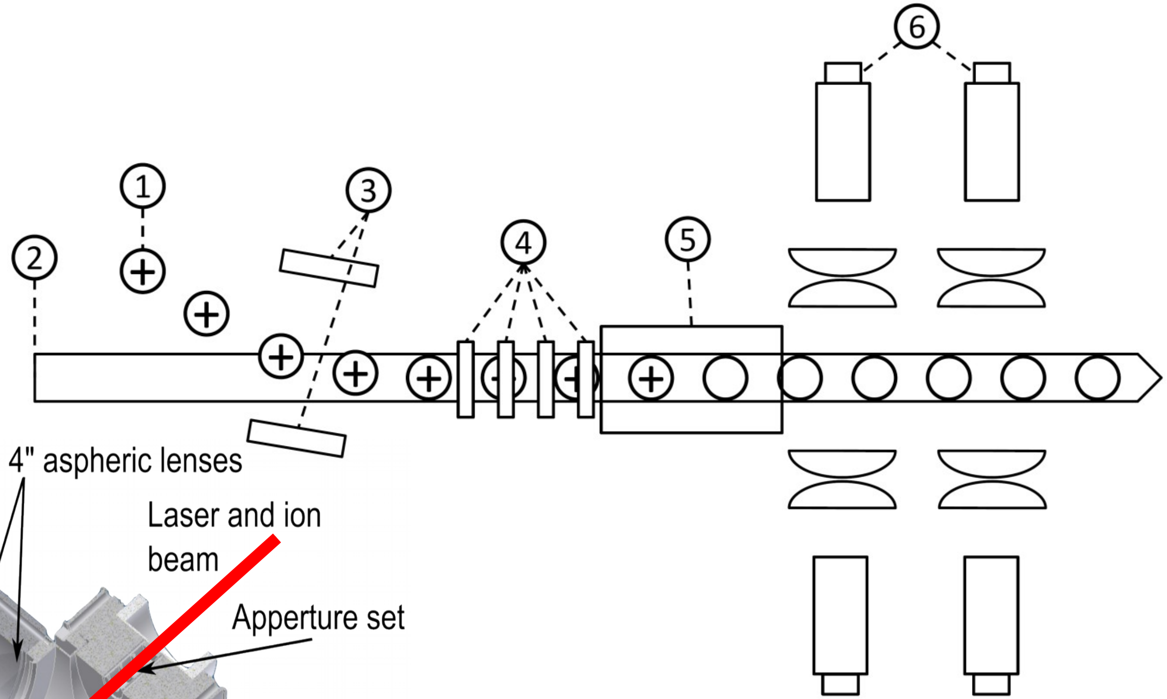


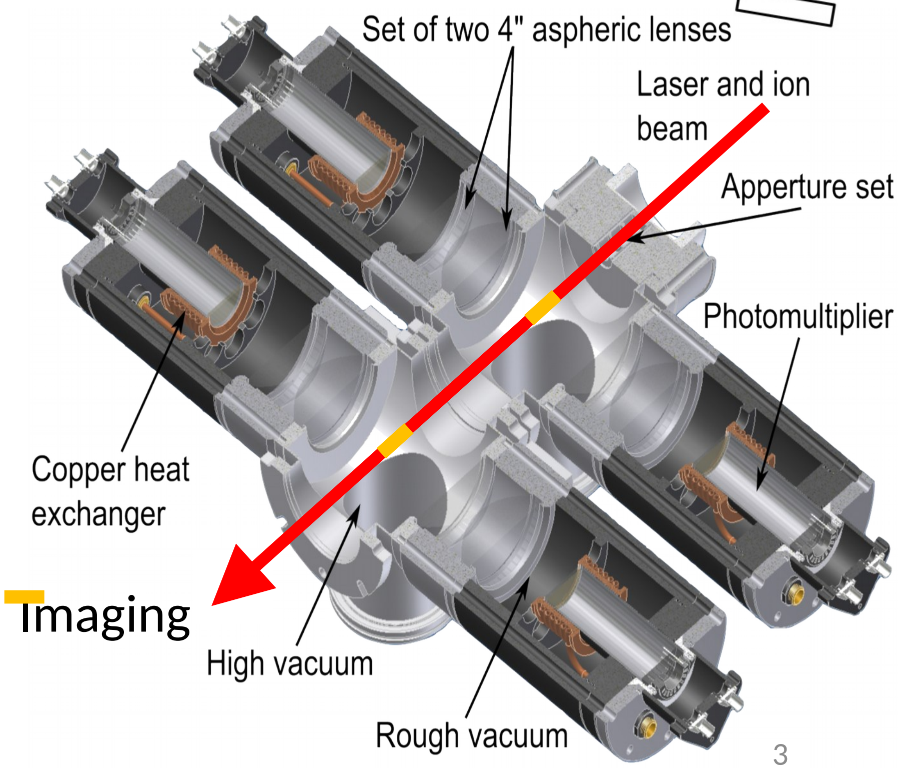


COLLINEAR LASER SPECTROSCOPY

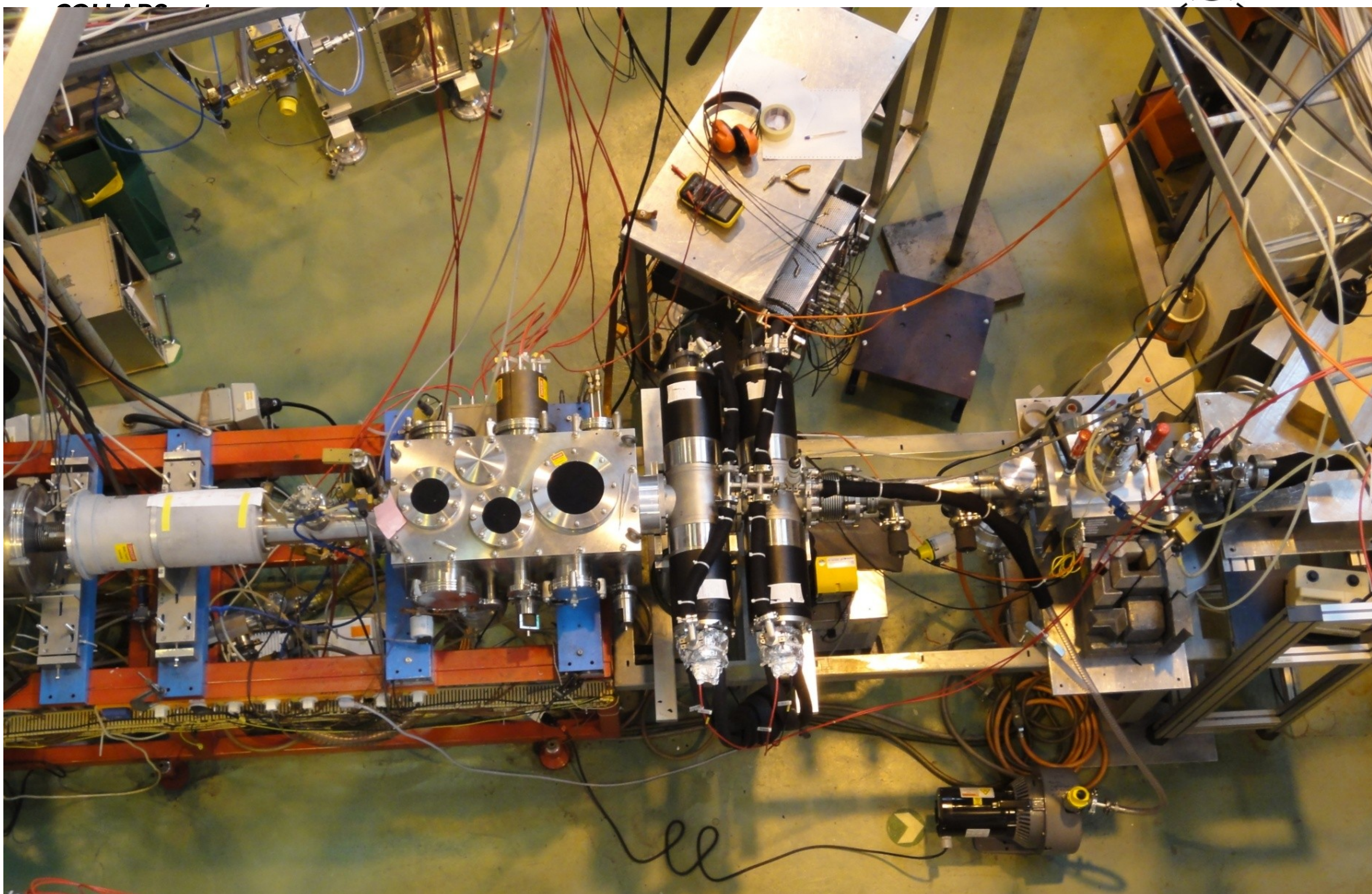
COLLAPS set-up

1.) ion beam;
2.) laser;
3.) deflection plates;
4.) post acceleration
5.) charge exchange;
6.) optical detection;



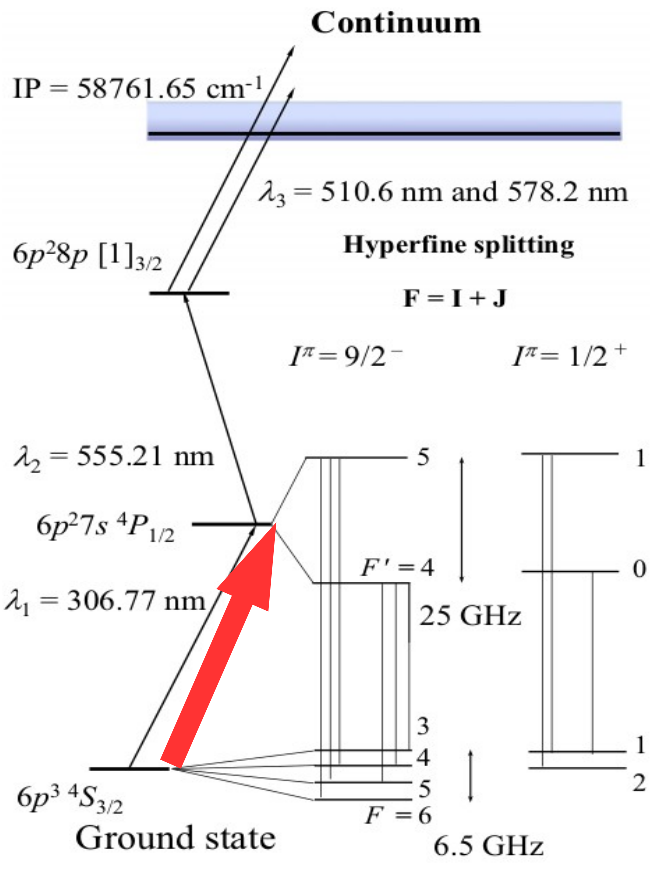


COLLINEAR LASER SPECTROSCOPY



Rough vacuum

COLLINEAR LASER SPECTROSCOPY

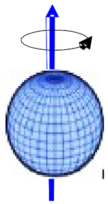


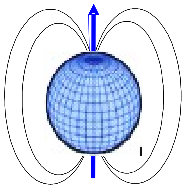
PHYSICAL REVIEW C **94**, 024334 (2016)

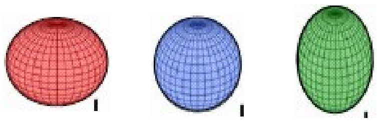
GS transition selected to provide maximum information for in-source spectroscopy.

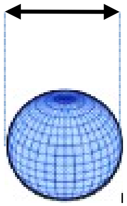
Very poorly populated in the charge exchange process.

Laser Spectroscopy Observables









Spin I

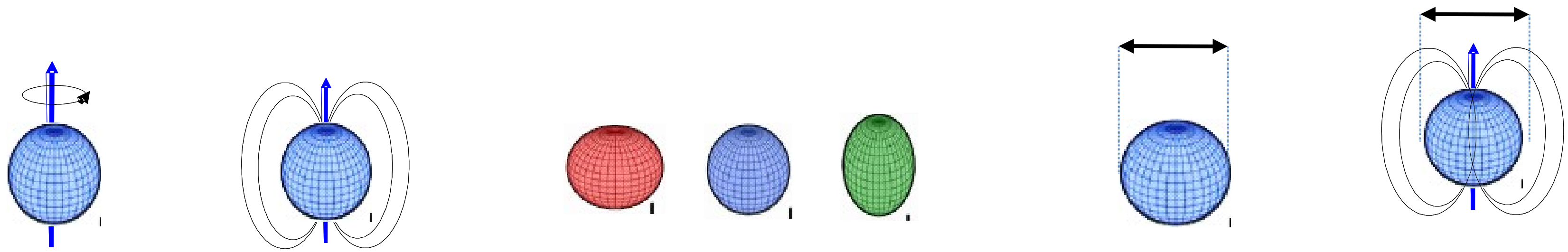
Spin I Magnetic moment μ Quadrupole moment Q_s Charge radii $\delta\langle r^2\rangle$

Structure / wave function

Correlations and deformation

Shape coexistence

Laser Spectroscopy Observables



Spin I

Spin I   Magnetic moment μ Quadrupole moment Q_s Charge radii $\delta\langle r^2\rangle$ + Hyperfine Anomalies

Structure / wave function

Correlations and deformation

Shape coexistence

Nuclear Magnetization Radius

The Hyperfine Anomaly

PHYSICAL REVIEW VOLUME 77, NUMBER 1 JANUARY 1, 1950

The Influence of Nuclear Structure on the Hyperfine Structure of Heavy Elements

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(Received September 27, 1949)

The influence on the h.f.s. of the finite size of the nucleus is considered and the effect is calculated for simple models of the nuclear magnetism. It is pointed out that the distribution of magnetic dipole density over the nuclear volume may vary greatly from nucleus to nucleus depending on the relative contributions of spin and orbital magnetic moments to the total nuclear moment. On this basis an attempt is made to interpret the observed discrepancy between the h.f.s. ratio of the Rb isotopes and the ratio of the magnetic moments as determined by the magnetic resonance method. A study of such anomalies may give some information regarding the structure of nuclear moments, in particular, regarding the nuclear g_L-factor.

I. INTRODUCTION

A RECENT accurate determination[1] of the nuclear moments of the Rb isotopes by the magnetic resonance method has indicated that the ratio of the h.f.s. splittings in Rb^{85} and Rb^{87}, measured previously with great precision,[2] does not agree exactly with the value calculated from the ratio of the moments, if the nuclei are considered as point dipoles. The h.f.s. ratio is found to be larger by 0.33 percent, while the experimental uncertainty involved in the comparison is judged to be about 0.05 percent.

It has been pointed out by Bitter[3] that anomalies

tion, the electron density varies approximately as $1-ZR^2/a_0R_0$, where R_0 is the nuclear radius.

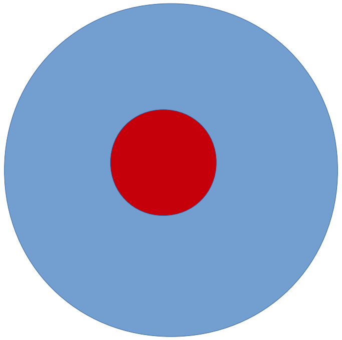
In a model in which the nuclear magnetic moment is considered as a smeared-out dipole distribution, the h.f.s. would thus be expected to differ from the value calculated for a point dipole at the nuclear center by a factor $1+\epsilon$, where

$$\epsilon \approx -(ZR_0/a_0)(R^2/R_0^2)_{\mathrm{Av}}. \quad (1)$$

For heavy atoms, relativity becomes of importance and its main effect in the present connection is to increase the absolute magnitude of the electron density at the

$A_1/g_1 \neq A_2/g_2$

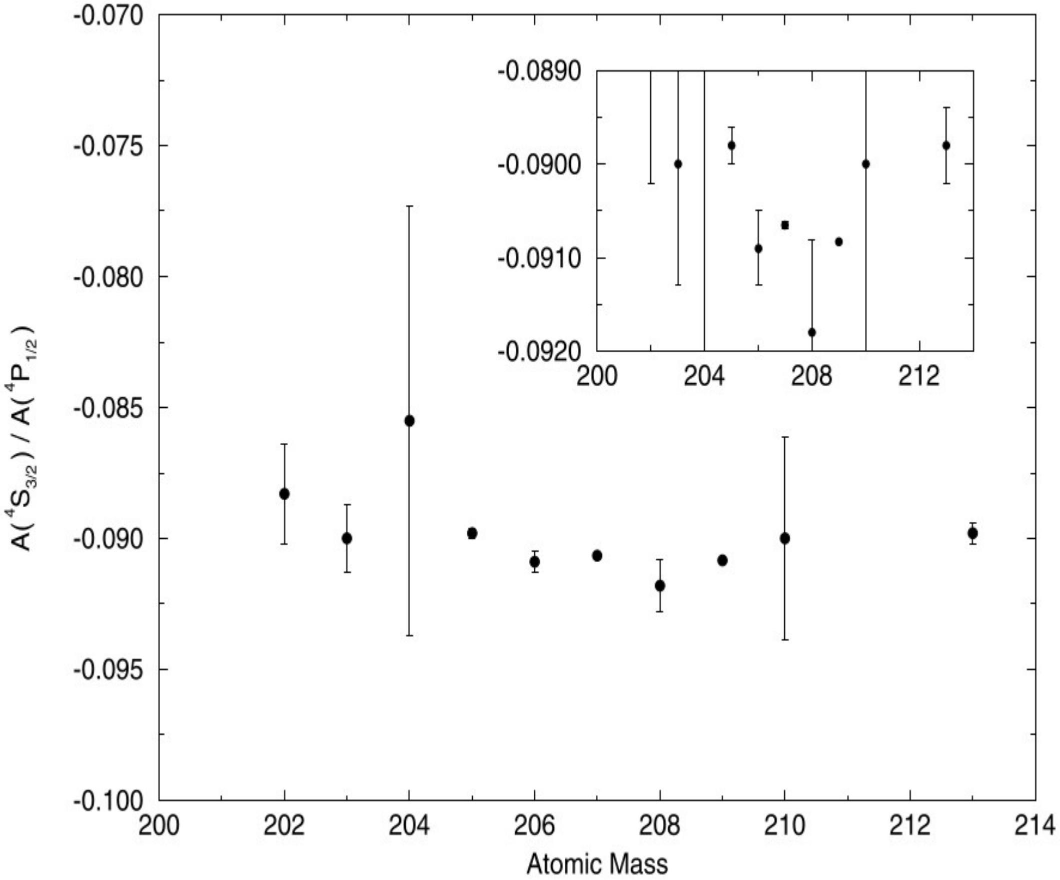
$W_A = W_L + W_{SD} + W_c$



$A = A_{point} + \varepsilon$

$$\boxed{\epsilon = -[(1+0.38\zeta)\alpha_s + 0.62\alpha_L]b(Z,R_0)(R/R_0)^2}$$

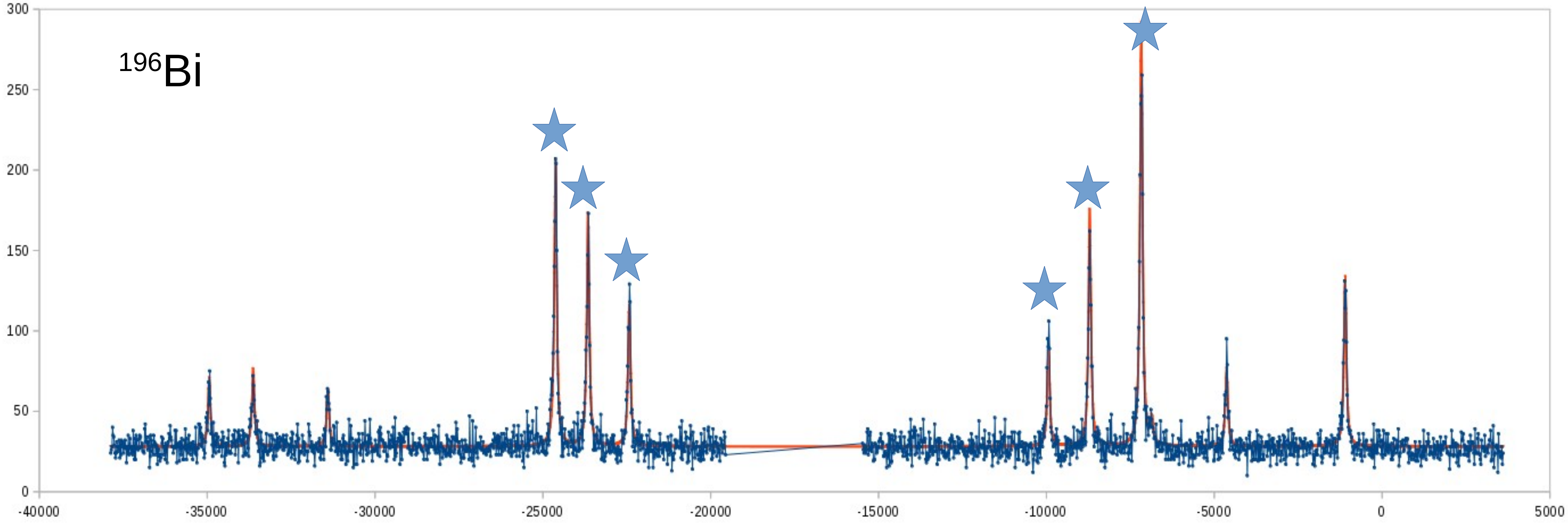
The Hyperfine Anomaly



J. Phys. G: Nucl. Part. Phys. **26** (2000) 1829–1848. Printed in the UK PII: S0954-3899(00)16812-4

Large HF anomaly between ^{205}Bi and ^{209}Bi.

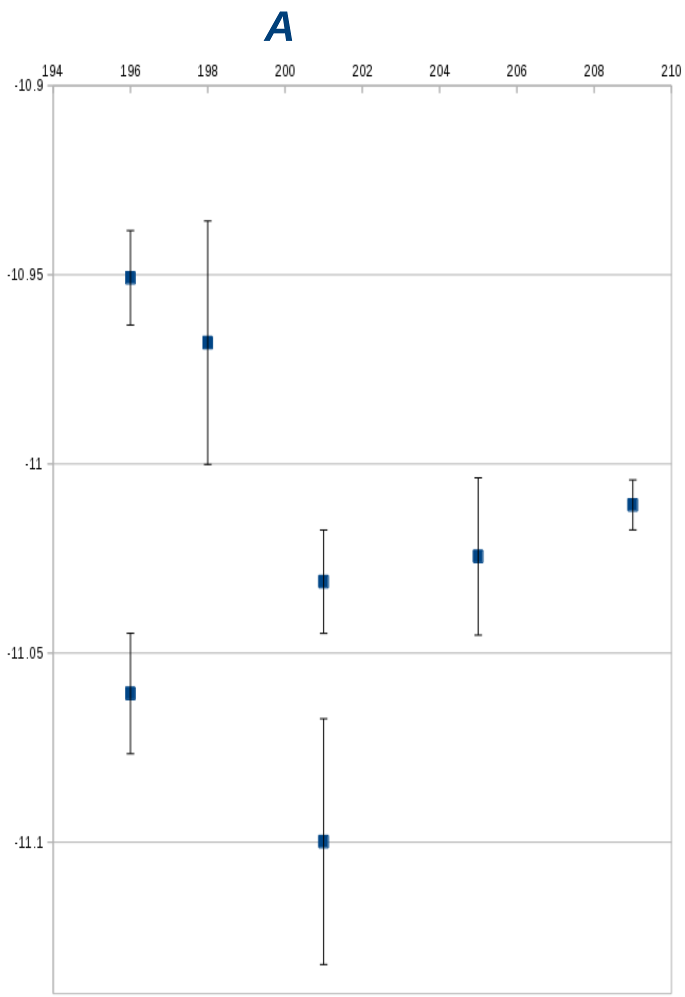
Results

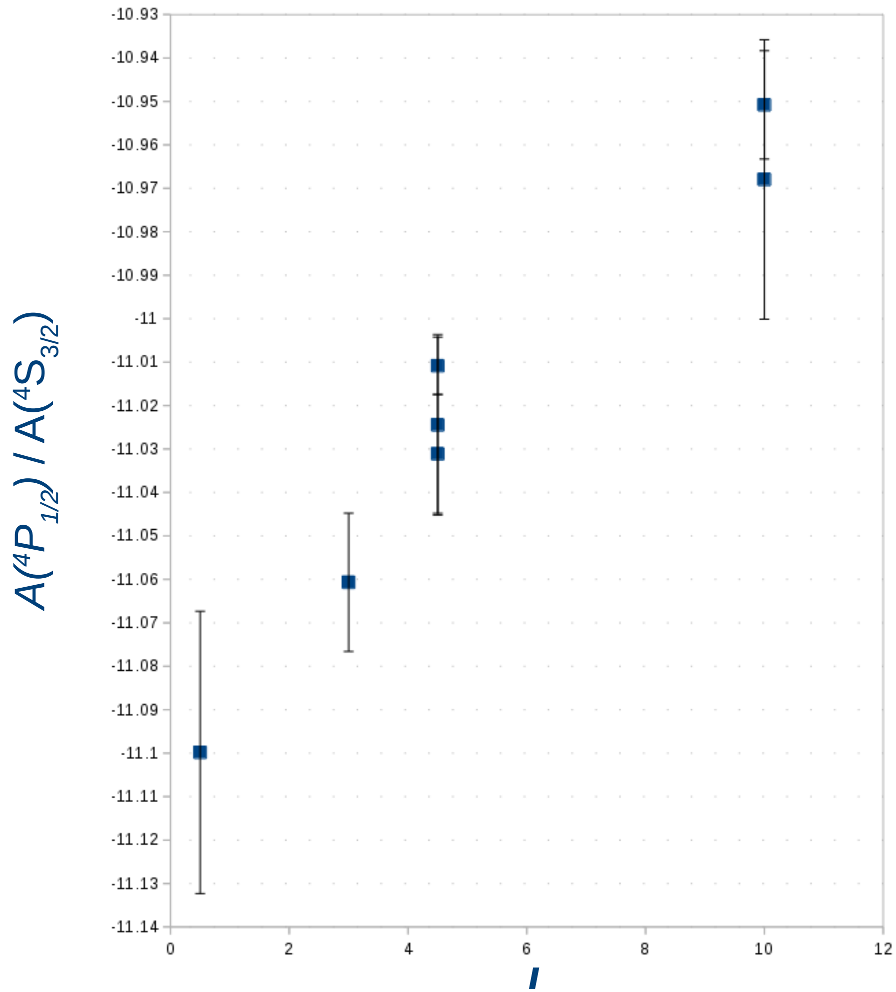


Measurements of a similar quality obtained for- 209,208,205,201,199,198,197Bi.

Analysis ongoing.

The Hyperfine Anomaly





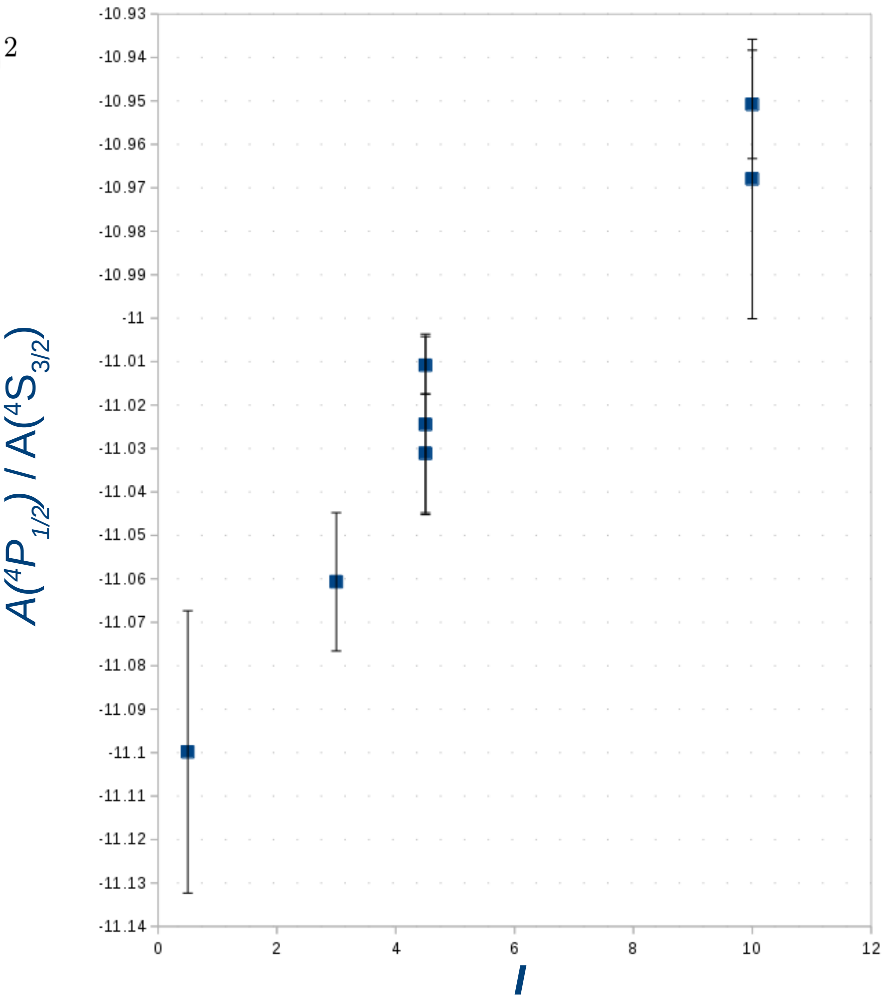
Interpretation?

$$\epsilon = -[(1+0.38\zeta)\alpha_s + 0.62\alpha_L]b(Z,R_0)(R/R_0)^2$$

b treated semi-empirically as p3/2 to s1/2.

Considered $^{201}Bi^m$ as pure π s1/2 and ^{209}Bi as a pure π h9/2.

→ Results consistent with a Change of R^2/R^2_0 from 0.3 to ~1.



Outlook

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Hyperfine Anomaly Measurements in Francium Isotopes and the Radial Distribution of Neutrons

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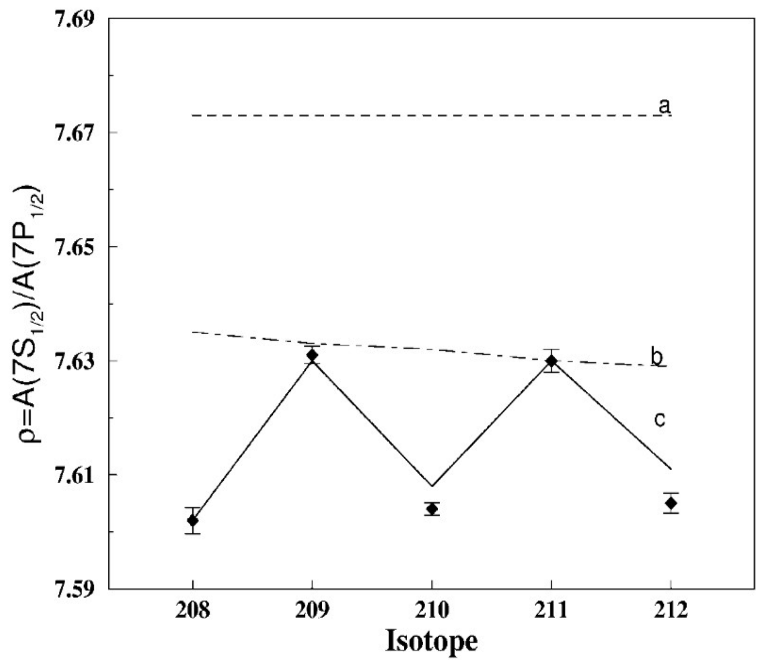
(Received 5 April 1999)



Planned measurements on Ag should be able to exploit one of the largest HFA's encountered.

Many other chains in the Pb reagion would offer simple access to the HFA over a wide range of isotopes.

Must be backed up by atomic theory support to obtain reliable conclusions.

MRTOF could offer possibilities to perform ultra high resolution Laser-RF double resonance experiments.

COLLAPS