



## New, highly deformed band found in praseodymium

An extraordinary sequence of  $\gamma$ -ray transitions has been observed from the nucleus praseodymium-131 in data obtained with the  $8\pi$  spectrometer and miniball.

The sequence is characteristic of large deformation but includes transitions that change the nuclear spin,  $J$ , by one unit rather than two. Only one similar case is known in the  $A=135$  Ce-Nd region.

States in this new band also extend to the lowest frequency yet observed for a superdeformed band ( $\hbar\omega = 0.17$  MeV), and may help to resolve anomalies previously observed at low frequencies.

## Unexpected feature seen in gadolinium-149

A new spectroscopic feature has been observed in the superdeformed rotational band of gadolinium-149 by a French/British/Canadian collaboration at the Eurogam gamma-ray spectrometer in Daresbury, England. Several TASCC and McMaster U. researchers were part of the experimental team.

Precise  $\gamma$ -ray energies measured with this instrument show that adjacent  $\Delta J=2$  rotational levels show a very small staggering of  $\pm 60$  electron volts about a smooth rotational sequence over a wide range of rotational frequency. Such effects have long been known in  $\Delta J=1$  rotational levels and arise from the breaking of rotational symmetry ( $R=\pi$ ) by the Coriolis force, but this is the first observation among  $\Delta J=2$  levels.

The recent unexpected result suggests the presence of some remnant  $R=\pi/2$  rotational symmetry and has stimulated great interest in the nuclear physics community.

## Facility report

TASCC's "15 MV" Tandem accelerator produced a record operating voltage of 15.27 MV during a scheduled physics experiment early in June. The voltage was maintained successfully to produce a 250 MeV beam of titanium-48 for 8.5 hours during a crystal-blocking experiment.

The superconducting cyclotron again successfully produced beam beyond its originally specified energy range. Low-currents of chlorine-35, accelerated to 43 MeV per nucleon, were provided for 172 hours during a study of particle fragmentation.

Resin columns for oxygen removal have now been installed in the facility deionized water system in an attempt to reduce corrosion of system piping. Several pin-hole leaks have developed recently in copper lines, with oxygen suggested as the culprit. Following a search for a commercial supplier of oxygen-removal systems, three columns of regenerable sulphite resin were installed within the current purification loop of mixed-bed columns. An on-line dissolved-oxygen monitor indicates that the initially high oxygen concentration is steadily being reduced.

Production tests of bismuth and lead beams are continuing on our ion-source test-stand. Reasonable currents are being produced, though with short cone life at this stage.

Beams produced for experiments during June were:

Ion	Energy (MeV)
$^{12}\text{C}$	95, 480
$^{19}\text{F}$	90
$^{35}\text{Cl}$	1505
$^{35-37}\text{Cl}$	100, 125
$^{37}\text{Cl}$	187
$^{48}\text{Ti}$	75 to 260
$^{128}\text{I}$	72

## Science Academy students try the real thing

The Deep River Science Academy is completing its seventh annual summer session. The 42 high school students attending this year's session receive a series of lectures and participate in a 'real' science project chosen from physics, chemistry or biology. Successful students receive high school diploma credits for the six-week course. Tutors for the students are hired from among university science students and spend 15 weeks working on their assigned projects.

This summer, TASCC is providing research projects in two areas. David Humphrey, an Academy tutor from U. of Waterloo, and Wafi Abdullah from Toronto, are working with ISOL's Mike Watson. They are measuring the thickening rates of different refractory foil windows placed at the entrance to the ISOL hot-cavity ion-source crucible. Measurements of the thickening of tantalum windows in the

presence of a carbon catcher indicate very high thickening rates – 5 milligrams per square centimetre per hour ( $\text{mg}/\text{cm}^2/\text{h}$ ) – at a heating power of 900 watts. Rates with a tungsten catcher are on average 1 to 1.5  $\text{mg}/\text{cm}^2/\text{h}$ .

In addition, this group successfully tested various tungsten catcher pellets of different open porosities and found one that was acceptable for use in the hot-cavity ion source.

The second area of DRSA research is on ECR ion source development. Becky Halko, tutor from the University of Guelph, James Oickle from Nepean, Ontario and Casey Monaghan from Balgonie, Saskatchewan are collaborating with TASCC's John Wills. They are developing internal source liners which, when heated by the plasma, will prevent condensation of non-volatile feed-stocks. They extracted a 2-milliamp beam of pure bismuth using a preliminary version of the liner.

The Deep River Science Academy has proven so successful that a second campus was opened this summer in Pinawa, Manitoba.

## June experiments

<b>Experiment</b>	Search for superdeformation in terbium-145 with the $8\pi$ spectrometer. No evidence was found for a ridge structure characteristic of superdeformation or for a discrete superdeformed band.
<b>Researchers</b>	S.M. Mullins, J. C. Waddington, G. Hackman, J. Jonkman, and J. Rodriguez ( <i>McMaster U.</i> ); A. Galindo-Uribarri, H.R. Andrews, D. Ward and V.P. Janzen ( <i>TASCC</i> )
<b>Beam</b>	187 MeV $^{37}\text{Cl}$
<b>Duration</b>	5 days

<b>Experiment</b>	Measurement of lifetimes of compound nuclei preceding heavy-ion- induced fission by crystal-blocking techniques. An excellent blocking pattern was observed from elastically scattered titanium ions of an energy similar to that expected for fission fragments. However, the peak characteristic of fission fragments was not evident in the particle spectrum.
<b>Researchers</b>	J.S. Forster, G.C. Ball, A. Galindo-Uribarri, J.S. Geiger and D. Bowman ( <i>TASCC</i> ); J.A. Davies ( <i>McMaster U.</i> )
<b>Beam</b>	75 to 260 MeV $^{48}\text{Ti}$
<b>Duration</b>	3 days

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**Experiment** Study of particle fragmentation mechanisms involving bombardment of targets of carbon, magnesium, aluminum and gold with a 35 MeV/u chlorine beam.

**Researchers** G. Anctil, L. Beaulieu, B. Djerroud, D. Doré, P. Gendron, E. Jalbert, Y. Larochelle, R. Roy, M. Samri and C. St-Pierre (*Université Laval*); D. Guinet and P. Lantesse (*Institut de Physique Nucléaire, Lyon*); G.C. Ball, D. Bowman, E. Hagberg, D. Horn and A. Galindo-Uribarri (*TASCC*)

**Beams** 43 MeV/u  $^{35}\text{Cl}$ ; (95 and 480 MeV  $^{12}\text{C}$  for calibrations)

**Duration** 12 days

**Experiment** Tuning and testing of new, wide-aperture multi-element detector for AMS. The avalanche section performed satisfactorily but resolution of the range section was restricted by excessive thickness and non-uniformity of the film electrodes used.

**Researchers** H.R. Andrews, W.G. Davies and V.T. Koslowsky (*TASCC*)

**Beams** 100, 125 MeV Cl

**Duration** 2 days

**Experiment** Study of low-spin states in erbium-166 with the  $8\pi$  spectrometer and miniball.

**Researchers** J.C. Waddington, S.M. Mullins, D. Haslip and L. Yao (*McMaster U.*); J. Degraaf (*U. of Toronto*); A. Galindo-Uribarri, V.P. Janzen, D.C. Radford and D. Ward (*TASCC*)

**Beam** 90 MeV  $^{19}\text{F}$

**Duration** 2 days

**Experiment** Study of radiation damage in simulated CANDU fuel bundles. Irradiation of Kr-implanted samples of  $\text{UO}_2$  and SIMFUEL produced very significant radiation-enhanced diffusion/release of the krypton. Further such studies will provide a firmer base for the diffusion coefficients currently used in reactor codes.

**Researchers** P.G. Lucuta and R.A. Verrall (*Fuel Engineering Branch, CRL*); J.S. Forster and H.R. Andrews (*TASCC*)

**Beam** 72 MeV  $^{128}\text{I}$

**Duration** 1 day

**Experiment** AMS measurements of the chlorine-36 content of approximately 80 environmental and rock samples with a new, larger-aperture detector, which improved counting efficiency over earlier work by a factor approaching four. A new method for processing rock samples showed that contamination problems can be reduced, with resulting  $^{36}\text{Cl}/\text{Cl}$  backgrounds in the  $10^{14}$  range.

**Researchers** R.R.J. Cornett, L.A. Chant, G.M. Milton and S. Kramer-Tremblay (*Environmental Research Branch, CRL*); H.R. Andrews, W.G. Davies, V.T. Koslowsky, J.C.D. Milton, B.F. Greiner, Y. Imahori and J.W. McKay (*TASCC*)

**Beam** 100 MeV Cl

**Duration** 3 days

*Always listen to experts. They'll tell you what can't be done and why.  
Then do it.*

ROBERT HEINLEIN

## Next month . . . . .

- Study of fusion-fission in vanadium-47
- Study of particle fragmentation mechanisms of high-energy chlorine beam on gold
- Cyclotron training for operators
- Depth profiling of hydrogen in zirconium
- Study of highly deformed band in praseodymium-131
- AMS studies of electrostatic fields on negative-ion lifetimes
- Measurement of lifetimes of states in vanadium-47
- Study of decay of vanadium-44

## Facility operating record

Elapsed Time (Year-to-date)	4439 h
Beam Available	
Tandem Only	2413.1
Tandem + Cyclotron	607.9
Beam Development	603
Planned Shutdown	497.5
Forced Shutdown	317.5

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