Contribution to the ISOLDE (2001) Newsletter

MISTRAL [1] - IS346/373 and IS384

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Since that last IS newsletter, a lot of ions have passed through the beampipe. MISTRAL has now had a total of five runs, producing two doctoral theses.

MISTRAL consists of a high resolution mass spectrometer that uses a rather special technique of coherent excitations of the ion kinetic energy at high harmonics of the ion cyclotron frequency to precisely determine nuclear binding energies.

After its installation and first beam in 1997, the first data-taking took place in July 1998 using the UC target and surface ionization source to measure Na isotopes out to A=30. A second run in November 1998 allowed us to verify the reproducability of these measurements. The results are presented in the thesis of C. Toader [2] , who spent half a year at ISOLDE during his studies.

These measurements exhausted the shift allocation of the initial proposal so a follow up was presented at the INTC meeting in February 1999, the acceptance of which changed MISTRAL's experiment number to IS373.

Emboldened by our success, in 1999 we attempted a run using the plasma ion source. While several mass peaks were recorded, many of them were contaminated by (often unknown) isobars. Despite the price paid in statistics due to the necessity of pushing the resolving power as high as possible and additional complications brought by reference ion instabilities, we did manage to produce measurements of $^{25-26}$Ne and the exotic ^{32}Mg. The analysis and discussion of these results constituted the doctoral thesis of C. Monsanglant[2] who was present at ISOLDE throughout 1999.

The nuclides ^{30}Na and ^{32}Mg constitute part of the famous island of inversion - a region around N=20 where deformation seems to overwhelm the normally stabilizing effect of the shell closure. The new precision brought by the MISTRAL measurements shows that these nuclides are in fact more bound than previously believed, enhancing this shell quenching, or "opening" effect. The Ne and Mg results will be published in the proceedings of the APAC2000 conference (Hyperfine Interactions, 2001) and the Na results have been submitted to Physical Review C.

Although MISTRAL is capable of high mass resolving power, even contaminant ions greatly differing in mass can overwhelm the peak of interest since they are transmitted at a different harmonic number. Separating such peaks requires changing the operating

[1] Mass measurements at ISOLDE using a Transmission, Radiofrequency spectrometer on-Line

[2] available from *http://csnwww.in2p3.fr/amdc/*

frequency which is not always possible due to insufficient performance of the RF modulator matching circuit.

One positive point glean from this experience was the demonstration of mass determinations using an isobar in the ISOLDE beam. This eliminates complications brought by using an auxilliary (reference) ion source.

A second run with the plasma ion source was attempted in May 2000 to try to combat the isobaric contamination problem by changing operating frequency but while clean measurements of $^{29-30}$Mg were made, the target yield was not sufficient to repeat the measurement of ^{32}Mg. A final run on Mg is scheduled for 2001 using the laser ion source in order to minimize contamination and hopefully, increase the yield.

Finally, another proposal, combining nuclear spectroscopy and mass measurements, was accepted by the INTC in 2000 for the study of the super-allowed beta emittor ^{74}Rb (see IS384). In December 2000, despite a failing target, we suceeded in measuring the mass of this nuclide. This result, combined with the values obtained by ISOLTRAP (IS302) for ^{74}Rb *and* ^{74}Kr, will help constrain the Q-value of the superallowed decay and in turn, to put the Standard Model to a test from a complementary, low-energy perspective. Our measurement will constitute part of the doctoral thesis of N. Vieira, who spent several weeks at ISOLDE during 1999 and 2000.

Upgrades underway include a shim-coil correction system to make the magnetic field more homogeneous and a new RF system to improve modulation amplitude and provide greater flexibility of operation.

The consequence of using the beam at full transport energy is that no constraints on half-life are imposed. However MISTRAL is currently limited in sensitivity to about 1000 ions per proton pulse which is insufficient for measuring the shortest-lived nuclides as practically all of them are produced with less intensity. Next year, we will install a gas-filled quadrupole emittance improver in order to increase the sensitivity and access these most exotic candidates.