Internal and external ionization in a mobile FTICR-MS

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Introduction.

Mobile FTICR based on permanent magnets are rugged instruments, possible to use in many different conditions for in situ real time measurements. They can also be easily coupled to photon sources such as synchrotron radiation lines or free electron lasers.

In the development presented here a permanent magnet assembly generates a field coaxial with the magnet cylinder axis. Ionization is possible in cell by electron impact or by chemical ionization. This magnetic configuration also allows for ionization outside the magnet and we have achieved the coupling with an external ionization source.

In the same instrument in cell chemical ionization can give absolute concentrations and an external glow discharge source operated at atmospheric pressure gives access to lower limit of detection.

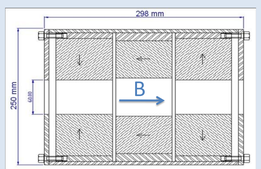
Mobile Axial Field ICR Analyzer

The results are obtained with a Mobile FTICR spectrometer featuring a permanent magnet producing a magnetic field coaxial with the magnet cylinder main axis.

The field is 1 Tesla and the relative homogeneity better than 10^{-3} in the cell volume.

The low field is an advantage for low mass detection since even for very low masses the cyclotron frequencies can detected if the bandwidth of the detection electronics is extended toward high frequencies.

Axial Field Magnet



Geometry of the magnet, composed of three cylinders : two of them are magnetized radially (inward and outward) and the middle one is magnetized axially.

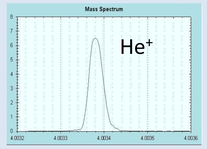
ICR cell

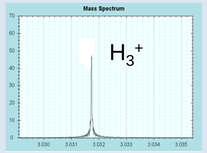
The cylindrical ICR cell is fitted with a filament on one side and externally generated ions can be injected through the center hole in the grid on the other side.

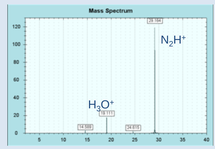
In cell chemical ionization.

Small permanent magnet FTICR are well suited for real time monitoring of gases at high resolution. Most of the applications of our spectrometers for air monitoring up to now have been realized using in cell chemical ionization for selective ionization of volatile organic compounds present in air at trace concentrations with detection of ions in the range m/z 10 to 300 now extended down to m/z 2.

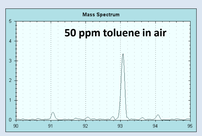
Precursors can be chosen between many different ions, such as H_3O^+ for selective ionization of most VOC, He^+ or Kr^+ for charge transfer ionization of most molecules, H_3^+ for very broadband proton transfer, CF_3^+ or OH^- for ionization of CFCs..

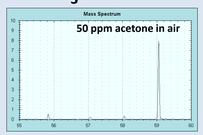


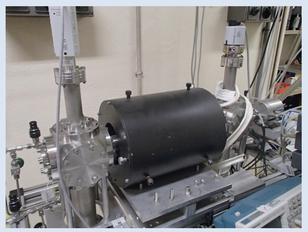




Ionization of traces in air with H_3O^+



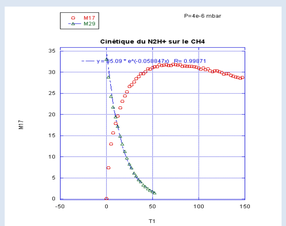




View of the instrument

The permanent magnet in black is in the middle. The two vacuum chambers are separated by a 1 mm diaphragm and contain the ICR cell on one side and the two hexapoles on the other side.

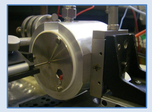
Reaction of N_2H^+ with CH_4



N_2H^+ ions are first formed using the $H_3^+ + N_2$ reaction and are then used to detect species such as CH_4 by proton transfer.

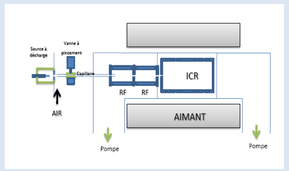
This can be a way to detect by chemical ionization species that are not ionized using proton transfer from H_3O^+

External glow discharge source.



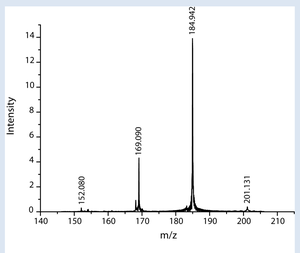
First tests on trace detection in air with an external ion source were made using a glow discharge ion source operated with helium at atmospheric pressure

Ion transfer.



Externaly generated ions are trapped in a first hexapole and transfered in the ICR cell through a second hexapole

Analysis of PAH in air.



Here air containing acenaphtylene at trace concentration is analyzed yielding a spectrum characteristic for this species, showing the molecular ion at m/z 152 as well as oxygenated ion products.

Conclusions

While with in cell chemical ionization realized in well defined conditions quantitative measurement are possible for concentrations between 1ppm up to 100% external ionization from a plasma source gives access to higher sensitivity and is well suited for the detection of low volatility species

Acknowledgement.

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