CLAIMS

What is claimed is:

1. A method of detecting specific gas species in an ion trap, the specific gas species initially being a trace component of a first low concentration in a volume of gas, the method comprising:

i) ionizing the gas including the specific gas species, thereby creating specific ion species;

ii) producing an electrostatic potential in which the specific ion species are confined in the ion trap to trajectories, at natural oscillation frequencies, in an electrode structure that includes first and second opposed mirror electrodes and a central lens electrode therebetween;

iii) exciting confined specific ion species with an AC excitation source having an excitation frequency;

iv) scanning the excitation frequency of the AC excitation source to eject the specific ion species from the ion trap; and

v) detecting the ejected specific ion species,

the method further comprising increasing the concentration of the specific ion species within the ion trap relative to the first low concentration prior to scanning the excitation frequency that ejects the ions of the specific gas species.

2. The method of claim 1, wherein increasing the concentration of specific gas species includes selective removal of gas species other than the specific gas species.

3. The method of claim 2, wherein selective removal is by trapping and ejecting other than the specific gas species prior to said scanning to eject the specific ion species.

4. The method of claim 2, wherein selective removal of gas species other than the specific gas species includes selective sorption of the gas species other than the specific gas species with a non-evaporable getter.

5. The method of claim 1, wherein increasing the concentration of specific gas species includes selective sorption of the specific gas species with a non-evaporable getter, followed by desorption of the specific gas species from the non-evaporable getter.

6. The method of any one of claims 1-5, wherein ionizing the specific gas species includes selective photoionization of the specific gas species to increase the concentration of the specific ion species.

7. The method of claim 6, further including data processing by integrating charge of specific gas species as a function of time.

8. The method of claim 6, wherein photoionization is by vacuum ultraviolet (VUV) photons with energies in the range of between about 8 eV and about 12 eV.

9. The method of claim 1, further comprising, prior to said scanning of the excitation frequency to eject the specific ion species, concentrating the specific ion species by previously trapping and previously ejecting the specific ion species.

10. The method of claim 9, further including confining the previously ejected specific ion species in a second electrode structure, thereby preferentially accumulating the specific ion species in the second electrode structure, said scanning to eject the specific ion species further ejecting the previously ejected specific ion species.

11. The method of any one of claims 1-10, further including filling the ion trap with a predetermined amount of gas.

12. An apparatus for detecting specific gas species in an ion trap, the specific gas species initially being a trace component of a first low concentration in a volume of gas, the apparatus comprising:

i) an ionizer that ionizes the gas including the specific gas species, thereby creating specific ion species;

ii) an electrode structure that produces an electrostatic potential in which the specific ion species are confined in the ion trap to trajectories, at natural oscillation frequencies, the electrode structure including first and second opposed mirror electrodes and a central lens electrode therebetween;

iii) an AC excitation source that excites confined specific ion species with an AC excitation frequency;

iv) a scan control that scans the excitation frequency of the AC excitation source to eject the specific ion species from the ion trap; and

v) a detector that detects the ejected specific ion species,

the apparatus adapted to increase the concentration of the specific ion species within the ion trap relative to the first low concentration prior to the scan control scanning the excitation frequency that ejects the ions of the specific gas species.

13. The apparatus of claim 12, further including a non-evaporable getter that removes gas species other than the specific gas species by selective sorption of the gas species other than the specific gas species.

14. The apparatus of claim 12, wherein the specific gas species is hydrogen, and the apparatus further includes a non-evaporable getter that increases the concentration of hydrogen by selective sorption followed by desorption of hydrogen from the non-evaporable getter.

15. The apparatus of any one of claims 12-14, wherein the scan control traps and ejects other than the specific gas species prior to said scanning to eject the specific ion species.

16. The apparatus of any one of claims 12-15, wherein the ionizer includes a selective photoionization source that increases the concentration of the specific ion species.

17. The apparatus of claim 16, wherein the photoionization source emits vacuum ultraviolet (VUV) photons with energies in the range of between about 8 eV and about 12 eV.

18. The apparatus of claim 16, wherein the detector integrates charge of specific gas species as a function of time.

19. The apparatus of claim 12, further comprising a second electrode structure that confines previously ejected specific ion species and thereby concentrates previously trapped and previously ejected specific ion species, prior to the scan control scanning the excitation frequency to eject the specific ion species.

CLAIMS

What is claimed is:

1. A method of detecting specific gas species in an ion trap, the specific gas species initially being a trace component of a first low concentration in a volume of gas, the method comprising:

i) ionizing the gas including the specific gas species, thereby creating specific ion species;

ii) producing an electrostatic potential in which the specific ion species are confined in the ion trap to trajectories, at natural oscillation frequencies, in an electrode structure that includes first and second opposed mirror electrodes and a central lens electrode therebetween;

iii) exciting confined specific ion species with an AC excitation source having an excitation frequency;

iv) scanning the excitation frequency of the AC excitation source to eject the specific ion species from the ion trap; and

v) detecting the ejected specific ion species,

the method further comprising increasing the concentration of the specific ion species within the ion trap relative to the first low concentration prior to scanning the excitation frequency that ejects the ions of the specific gas species;

the method further comprising increasing the concentration of the specific gas species by either:

a) selective removal of gas species other than the specific gas species by selective sorption of the gas species other than the specific gas species with a non-evaporable getter; or

b) selective sorption of the specific gas species with a non-evaporable getter, followed by desorption of the specific gas species from the non-evaporable getter.

2. The method of Claim 1, wherein the specific gas species is hydrogen and the non-evaporable getter increases the concentration of hydrogen by selective sorption followed by desorption of hydrogen from the non-evaporable getter.

3. The method of claim 1 or 2, wherein ionizing the specific gas species includes selective photoionization of the specific gas species to increase the concentration of the specific ion species.

4. The method of claim 3, further including data processing by integrating charge of specific gas species as a function of time.

5. The method of claim 3, wherein photoionization is by vacuum ultraviolet (VUV) photons with energies in the range of between about 8 eV and about 12 eV.

6. The method of claim 1, further comprising, prior to said scanning of the excitation frequency to eject the specific ion species, concentrating the specific ion species by previously trapping and previously ejecting the specific ion species.

7. The method of claim 6, further including confining the previously ejected specific ion species in a second electrode structure, thereby preferentially accumulating the specific ion species in the second electrode structure, said scanning to eject the specific ion species further ejecting the previously ejected specific ion species.

8. The method of any one of claims 1-7, further including filling the ion trap with a predetermined amount of gas.

9. An apparatus for detecting specific gas species in an ion trap, the specific gas species initially being a trace component of a first low concentration in a volume of gas, the apparatus comprising:

i) an ionizer that ionizes the gas including the specific gas species, thereby creating specific ion species;

ii) an electrode structure that produces an electrostatic potential in which the specific ion species are confined in the ion trap to trajectories, at natural oscillation

frequencies, the electrode structure including first and second opposed mirror electrodes and a central lens electrode therebetween;

iii) an AC excitation source that excites confined specific ion species with an AC excitation frequency;

iv) a scan control that scans the excitation frequency of the AC excitation source to eject the specific ion species from the ion trap; and

v) a detector that detects the ejected specific ion species,

the apparatus adapted to increase the concentration of the specific ion species within the ion trap relative to the first low concentration prior to the scan control scanning the excitation frequency that ejects the ions of the specific gas species, the apparatus further comprising a non-evaporable getter that either:

a) removes gas species other than the specific gas species by selective sorption of the gas species other than the specific gas species; or

b) increases the concentration of the specific gas species by selective sorption followed by desorption of the specific gas species from the non-evaporable getter.

10. The apparatus of Claim 9, wherein the specific gas species is hydrogen and the non-evaporable getter increases the concentration of hydrogen by selective sorption followed by desorption of hydrogen from the non-evaporable getter.

11. The apparatus of claim 9 or 10, wherein the scan control traps and ejects other than the specific gas species prior to said scanning to eject the specific ion species.

12. The apparatus of claim 9-11, wherein the ionizer includes a selective photoionization source that increases the concentration of the specific ion species.

13. The apparatus of claim 12, wherein the photoionization source emits vacuum ultraviolet (VUV) photons with energies in the range of between about 8 eV and about 12 eV.

14. The apparatus of claim 12, wherein the detector integrates charge of specific gas species as a function of time.

15. The apparatus of claim 9, further comprising a second electrode structure that confines previously ejected specific ion species and thereby concentrates previously trapped and previously ejected specific ion species, prior to the scan control scanning the excitation frequency to eject the specific ion species.