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现代应用光学

简并四波混频用于铷、铯和钾同位素痕量测量

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摘要： 考虑用质谱法进行同位素分析存在分辨率有限、检出限高、样品预处理过程复杂等缺陷，提出了采用简并四波混频（DFWM）光谱技术来测量和分析同位素。选择氯化物中的Rb、Cs和K的同位素作为测试样品，用石墨炉原子化器将化合物原子化为原子蒸汽。通过对Rb、Cs和K的同位素进行分析发现：DFWM 光谱技术的分辨率很高，能够清楚地分辨3种元素的同位素以及超精细能级跃迁； 对RbCl样品中的Rb同位素的丰度比值进行了测量，得到的丰度比值为（2.649±0.002)，精度优于传统质谱法的测量结果。此外，DFWM光谱技术测量Rb，Cs和K同位素的检出限分别为 5.4 fg/mL，0.63 pg/mL和0.09 fg/mL。实验结果表明，相对于质谱法，DFWM光谱技术的测量精度更高，检出限更低，在同位素分析中具有明显的优势。

关键词：

Trace measurement of rubidium, cesium and potassium isotope with degenerate four-wave mixing method

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Abstract: In consideration of the drawbacks of mass-spectrometry in isotope analysis, a spectroscopy based on Degenerate Four-wave Mixing (DFWM) was proposed to analyze atomic isotopes and to overcome these limitations, like limited resolution, higher detection limits and complex sample preprocessing. Rubidium (Rb), cesium (Cs) and potassium (K) isotopes were selected as measured samples and an atomizer based on graphite oven was used to atomize these compounds into atomic steams. The analytic results show that the DFWM spectroscopy has a higher resolution and it can distinguish isotopes and hyperfine structures of the three elements clearly. The measured isotope abundance ratio of Rb isotope is (2.649±0.002), which is superior to the sensitivity of traditional mass spectroscopy. The detection limits of proposed method is as low as 5.4 fg/ml, 0.63 pg/mL and 0.09 fg/mL for Rb, Cs and K isotopes,respectively. Obtained results demonstrate that the spectroscopy based on DFWM has a higher resolution, lower detection limit and is more suitable for the isotope analysis as compared with the origional mass spectrometry.

Keywords: nonlinear spectrometry   Degenerate Four-wave Mixing(DFWM) method   isotope   trace mesurement   resolution   detection limit

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