4 - 12 Investigation on Forbidden Lines of Magnetic Dipole Transitions $4p^{23}P_1$–$^3P_0$ in Rh^{13+} *

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Forbidden lines of highly charged ions (HCIs) have attracted attention for many years in various aspects. Magnetic dipole transition (M1) in the $4p^{23}P$ fine-structure manifold of Rh^{13+} was proposed as a candidate for the ultraprecise optical clock transition due to the low degeneracy of the clock levels and the suppression of relevant quadrupole shifts. Such transition possessing optical transitions with very narrow natural width and less susceptibility to external field perturbations, provides opportunities to build frequency standards with fraction accuracies of 10^{-19} or below. In addition, such clock transition is more sensitive to the time-variation of the fine-structure constant α and the electron-electron correlations, therefore its precise experimental and theoretical inversitgations become the good tools to estimate these effects and contributions.

In this work, a first direct observation of the $4p^{23}P_1 - {}^3P_0$ clock transition in Rh^{13+} is performed in a permanent magnet electron beam ion trap (CUBIT) sited at the Fudan university, by utilizing a well-established internal calibration method with well-known Ne^+ spectra as reference lines. Such reference lines are simultaneously emitted from the same region of the measured lines, thereby the systematic uncertainties caused by the location difference of the lines, system vibration and temperature drift, *etc.*, could be significantly suppressed and reduced. The wavelength of the $4p^{23}P_1 - {}^3P_0$ clock transition in $Rh^{13+}$with a precision at a few ppm level is obtained as 321.2150(14) nm (in air), leading to more than two orders of magnitude improvement compared to other measurements. Additionally, the MCDHF calculation is adopted to estimate the hyperfine effect in the external magnetic field, which shows the negligible shift of the wavelength[1].

Table 1 Summary wavenumbers (in vacuum) of the fine structure splitting of Rh^{13+} $4p^{23}P_1 - {}^3P_0$ from the present work and the previous studied. (The more details for this table can be found in Ref. [1])

	Wavenumber/cm^{-1}	Method
Expt.	31122.81(0.14)	EBIT (this work)
	31133(160)	Laser-produced plasmas
	31100(50)	Laser-produced plasmas
Theo.	31080.30	MCDHF (this work)
	31116	GLS fit
	31198	HXR approach
	31113	Extrapolation

Reference

[1] Y. Wang, Y. Li, J. Liu, et al., J. Quant. Spectrosc. Radiat. Transfer, 293(2022)108370.

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