QUESTにおける水素分子$d\,^3\Pi$準位回転温度を利用したタングステン表面温度計測

Estimation of Tungsten Surface Temperature from $d\,^3\Pi$ State Rotational Temperature of Hydrogen Molecules in QUEST

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Purpose: Development of thermometry less affected by the changes in surface using $d\,^3\Pi$ state rotational temperature of H_2 (T_{rot}^d)

Questions

- $T_{\mathrm{rot}}^d \to T_{\mathrm{wall}}$ as $n_{\mathrm{e}} \to 0$?
- Is the relation independent from wall materials?

T_{wall}: wall temperature
n_{e}: electron density

Results

- T_{rot}^d approaches T_{wall} as $n_{\mathrm{e}} \to 0$
- Independent from wall materials

Result in LTX-β (lithium wall)

Result in QUEST (tungsten wall)

Previous Researches

- For graphite wall (TEXTOR) [1]
  $T_{\mathrm{rot}}^d \to T_{\mathrm{wall}}$ as $n_{\mathrm{e}} \to 0$ [1] E.M. Hollmann, *et al.*, *PPCF*, **48**, 1165 (2006)
- For lithium wall (LTX-β)
  $T_{\mathrm{rot}}^d \to T_{\mathrm{wall}}$ as $n_{\mathrm{e}} \to 0$
  (on the assumption of linear increase in T_{rot}^d with n_{e})

Method

- Measured H_2 emission spectra for tungsten wall of QUEST
- Derived radial distribution of emissivity
  assuming toroidal symmetry
- Estimated T_{rot}^d assuming a Boltzmann distribution.
- Evaluated the increase by electron-collision excitation

Approximation of T_{rot}^d

l_{wall}: distance from the hot wall

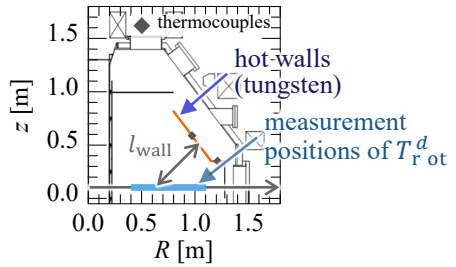
$$T_{\mathrm{rot}}^d(l_{\mathrm{wall}}) = T_{\mathrm{wall}} + \int_0^{l_{\mathrm{wall}}} C_{\mathrm{e}}' \cdot n_{\mathrm{e}}(l)\,dl$$

Increase by electron-collision excitation

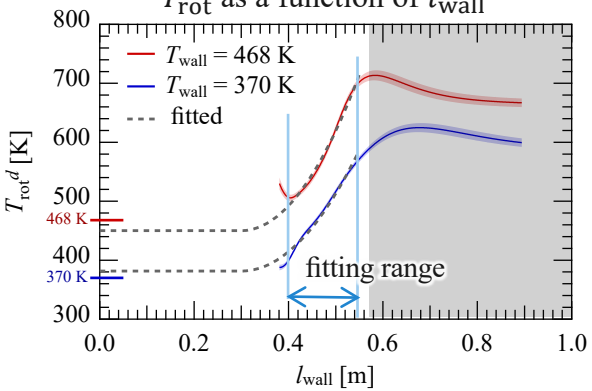
For $\Delta l \ll 1$ (for LTX-β)
$T_{\mathrm{rot}}^d(\Delta l) = T_{\mathrm{wall}} + C_{\mathrm{e}}' \cdot n_{\mathrm{e}}(\Delta l) \cdot \Delta l$

⇨ Agreement of results with the model

Poloidal cross section of QUEST



T_{rot}^d as a function of l_{wall}



Supported by Mori Manufacturing Research and Technology Foundation (森記念製造技術研究財団), Japan / U. S. Cooperation in Fusion Research and Development (日米科学技術協力事業(核融合分野)), and USDoE contracts DE-AC52-07NA27344 (LLNL) and DE-AC02-09CH11466 (Princeton University).