DYNAMICAL INFORMATION FOR KINETIC MODELING AND TRANSPORT PROPERTIES OF HE/H_2 PLASMAS

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CRP (COORDINATED RESEARCH PROJECT), IAEA MEETING "ATOMIC and MOLECULAR DATA for PLASMA MODELING"
VIENNA, 3-5 JULY 2013

MODELING of PLASMA SYSTEMS
for FUSION applications

STATE-TO-STATE KINETIC APPROACH

MODELING of PLASMA SYSTEMS
for FUSION applications

non-equilibrium
internal distributions

⇩

state-to-state kinetics

⇩

state-resolved cross sections and rate coefficients

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features of MD calculations

- ✓ *vibrational and rotational dependence*
- ✓ *completeness*
- ✓ *scaling relations*
- ✓ *isotopic effect*
- ✓ *fitting formulas*

✓ RVE and DEA in e-H_2 *through Rydberg resonant state*

$$H_2(X^1\Sigma_g^+, v_i, j_i) + e \rightarrow H_2^-(^2\Sigma_g^+) \rightarrow H_2(X^1\Sigma_g^+, v_f, j_f) + e$$
$$H_2(X^1\Sigma_g^+, v_i, j_i) + e \rightarrow H_2^-(^2\Sigma_g^+) \rightarrow H^-(^1S) + H(n=2)$$

✓ VTa and CID in He-H_2 collisions

$$He(^1S) + H_2(^1\Sigma_g^+, v_i, j_i) \rightarrow He(^1S) + H_2(^1\Sigma_g^+, v_f, j_f)$$
$$He(^1S) + H_2(^1\Sigma_g^+, v_i, j_i) \rightarrow He(^1S) + H(^2S) + H(^2S)$$

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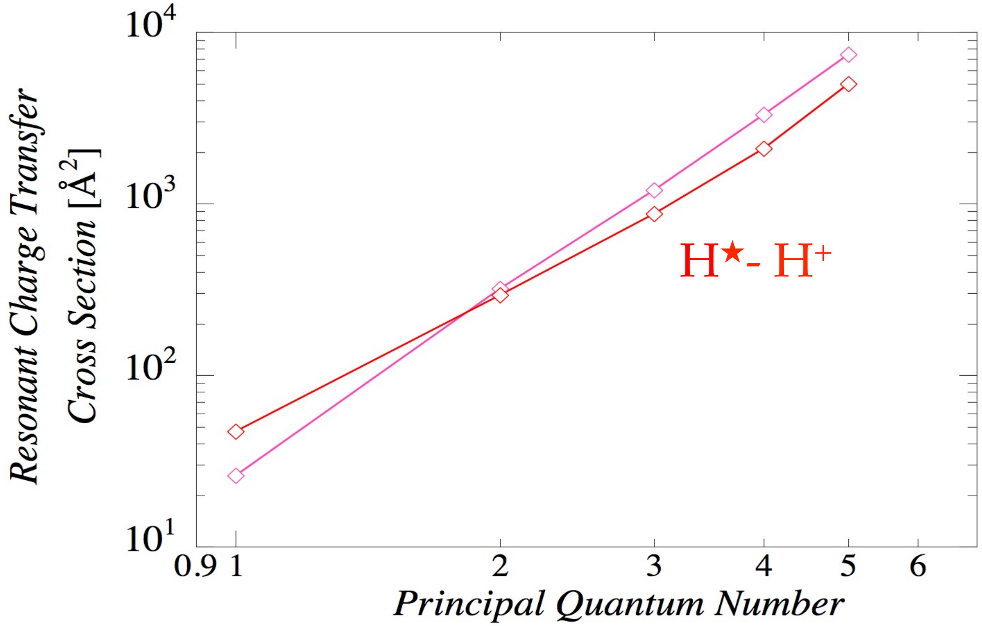
$$\mathrm{He}^{\star}(1s\ n\ell)\text{-}\mathrm{He}^{+}(^{2}S)$$

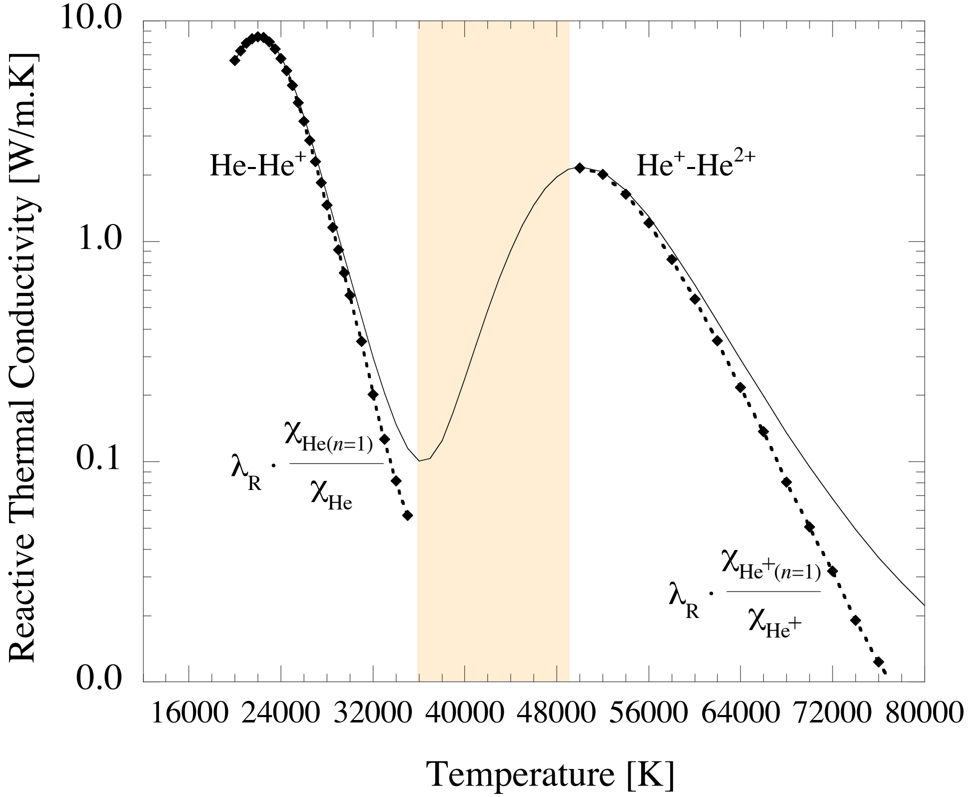


asymptotic approach

$$\sigma_{n\ell} = \frac{\sigma_{n\ell 0} + 2\sum_{\mu}\sigma_{n\ell\mu}}{2\ell + 1}$$

[A.V. Kosarim et al. Phys of Plasmas 19 (2012) 062309]

REACTIVE THERMAL CONDUCTIVITY OF He PLASMAS IN IONIZATION REGIME



$$\lambda_R = \frac{p}{RT}\mathcal{D}_{\mathrm{He-He^+}}\frac{\chi_{\mathrm{He}}\chi_{\mathrm{He^+}}}{(\chi_{\mathrm{He}}+\chi_{\mathrm{He^+}})^2}\frac{\Delta H^2}{RT^2}$$

$$\lambda_R = \frac{p}{RT}\mathcal{D}_{\mathrm{He^+-He^{2+}}}\frac{\chi_{\mathrm{He^+}}\chi_{\mathrm{He^{2+}}}}{(\chi_{\mathrm{He^+}}+\chi_{\mathrm{He^{2+}}})^2}\frac{\Delta H^2}{RT^2}$$

⇩

Simplified Approach for
Reactive Thermal Conductivity
accounting for excited states

$$\lambda_R \simeq \frac{p}{RT}\mathcal{D}_{\mathrm{He}(n=1)-\mathrm{He^+}}\frac{\chi_{\mathrm{He}(n=1)}\chi_{\mathrm{He^+}}}{(\chi_{\mathrm{He}(n=1)}+\chi_{\mathrm{He^+}})^2}\frac{\Delta H^2}{RT^2}$$

$$\lambda_R \simeq \frac{p}{RT}\mathcal{D}_{\mathrm{He^+}(n=1)-\mathrm{He^{2+}}}\frac{\chi_{\mathrm{He^+}(n=1)}\chi_{\mathrm{He^{2+}}}}{(\chi_{\mathrm{He^+}(n=1)}+\chi_{\mathrm{He^{2+}}})^2}\frac{\Delta H^2}{RT^2}$$

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