AFRL-AFOSR-JP-TR-2019-0057

Accurate collision data for hydrogen and helium plasmas

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09/12/2019
Final Report

DISTRIBUTION A: Distribution approved for public release.

Air Force Research Laboratory
Air Force Office of Scientific Research
Asian Office of Aerospace Research and Development
Unit 45002, APO AP 96338-5002

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
12-09-2019

2. REPORT TYPE
Final

3. DATES COVERED *(From - To)*
25 May 2017 to 24 Nov 2018

4. TITLE AND SUBTITLE
Accurate collision data for hydrogen and helium plasmas

5a. CONTRACT NUMBER

5b. GRANT NUMBER
FA2386-17-1-4055

5c. PROGRAM ELEMENT NUMBER
61102F

6. AUTHOR(S)
Igor Bray

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
CURTIN UNIVERSITY OF TECHNOLOGY
BLDG 100, KENT STREET
BENTLEY, 6102 AU

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AOARD
UNIT 45002
APO AP 96338-5002

10. SPONSOR/MONITOR'S ACRONYM(S)
AFRL/AFOSR IOA

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
AFRL-AFOSR-JP-TR-2019-0057

12. DISTRIBUTION/AVAILABILITY STATEMENT
A DISTRIBUTION UNLIMITED: PB Public Release

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This project was about generating collision data involving collisions occuring inside astrophysical and fusion plasmas containing molecules of hydrogen or helium.

15. SUBJECT TERMS
molecular transitions, molecular excitation, deuterium, tritium

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
Unclassified	Unclassified	Unclassified	SAR		KNOPP, JEREMY
					19b. TELEPHONE NUMBER *(Include area code)* 315-227-7006

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

Final Report 17IOA055: Accurate collision data for hydrogen and helium plasmas

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This project was about generating collision data involving collisions occuring inside astrophysical and fusion plasmas containing molecules of hydrogen or helium. Much of this work is being done in collaboration with our past student Mark Zammit, who is now a staff scientist at the Loas Alamos National Laboratory (LANL). The support of LANL for the continual access to Mark is gratefully appreciated, and has meant that a great deal more has been achieved with original funding extended to cover 2017 and 2018. The number of publications arising is rather large, see [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17], where we met the original goals, but also had an opportunity to extend our techniques to photon scattering with the potential application to Quantum Radar [18].

Concentrating on just one highlight, theoretical development is only of practical value when it is able to be predictive. An excellent way of demonstrating this is when the calculated results show discrepancy with previous experiement, but subsequent more accurate experiments confirm the theoretical predictions of the molecular convergent close-coupling (MCCC) computational method. An example of this was published recently as a Rapid Communication [5]. The figure below shows that old measurements were substantially above our theoretical predictions. However, new measurements, carried out in response to the identified discrepancy with much smaller error bars, are in perfect agreement with the calculations. This particular cross section is very important in plasma physics because it leads to the breakup of the H_2 molecule into two H atoms.

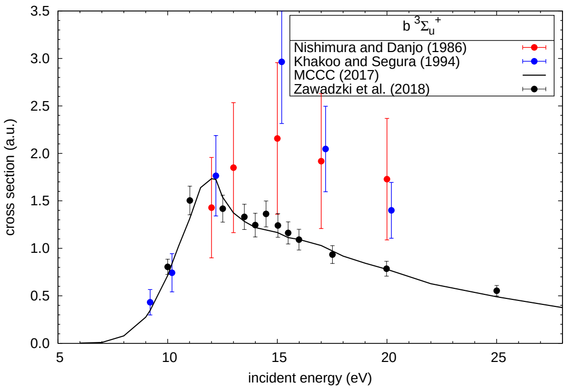

Figure 1: Cross section for electron-impact excitation of the ground state of H_2 to the specified state, see Ref.[5] for details.

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