User perspectives on the current state of He I data

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Outline :

- Status of electron and proton collision data
- Slow Helium (e.g. thermal he beams)
- Fast Helium beams from ion sources

Electron collision data

Historically: Vainshtein's work; later de Heer's review for excitation from ground state / early R-matrix calculation (Berrington,…)

Breakthrough with CCC excitation and ionisation data by I. Bray et al [Y Ralchenko et al NIFS-DATA-59,2000]

Substantial ADAS review based on RMPS excitation data (Connor, Hugh, Ian) in 2004/5

- increased accuracy at very low energies
- adf04 table rather than polynomial fits

Accuracy seems to be sufficient – errors of excited state population dominated by different effects

Proton collision data – excitation (I)

Fundamental data by far not satisfying

There is some ADAS adf02 from Harvey's days based on ground state excitation data by Hoekstra & de Heer from the late 90's / some impurity data – but nothing for the excited states

Recent publications for proton excitation out of excited states

- Chibisov (excitation and CX for n=2..3, E~10-10^4eV, close coupling calc.) [J. Phys. B: At. Mol. Opt. Phys. **35** (2002) 5081–5093]
- Beigman (excitation Born / ATOM, E=1..10^5 eV)

  [Optics and Spectroscopy, Vol. 95, No. 4, 2003, pp. 493–506]

<u>This is not state of the art data!</u>

Proton collision data – excitation (II) and CX

IAEA publication [Dimitriou,Aumayr et al] is announced for APID volume 13 – this is a compilation of available data
(for excited states based on Chibisov only)

APID 13 not yet published but available in Aladdin !

www-amdis.**iaea**.org/**ALADDIN**/

Status of thermal He model

ADAS208 high n model and recent n=1..4 excitation and ionisation data

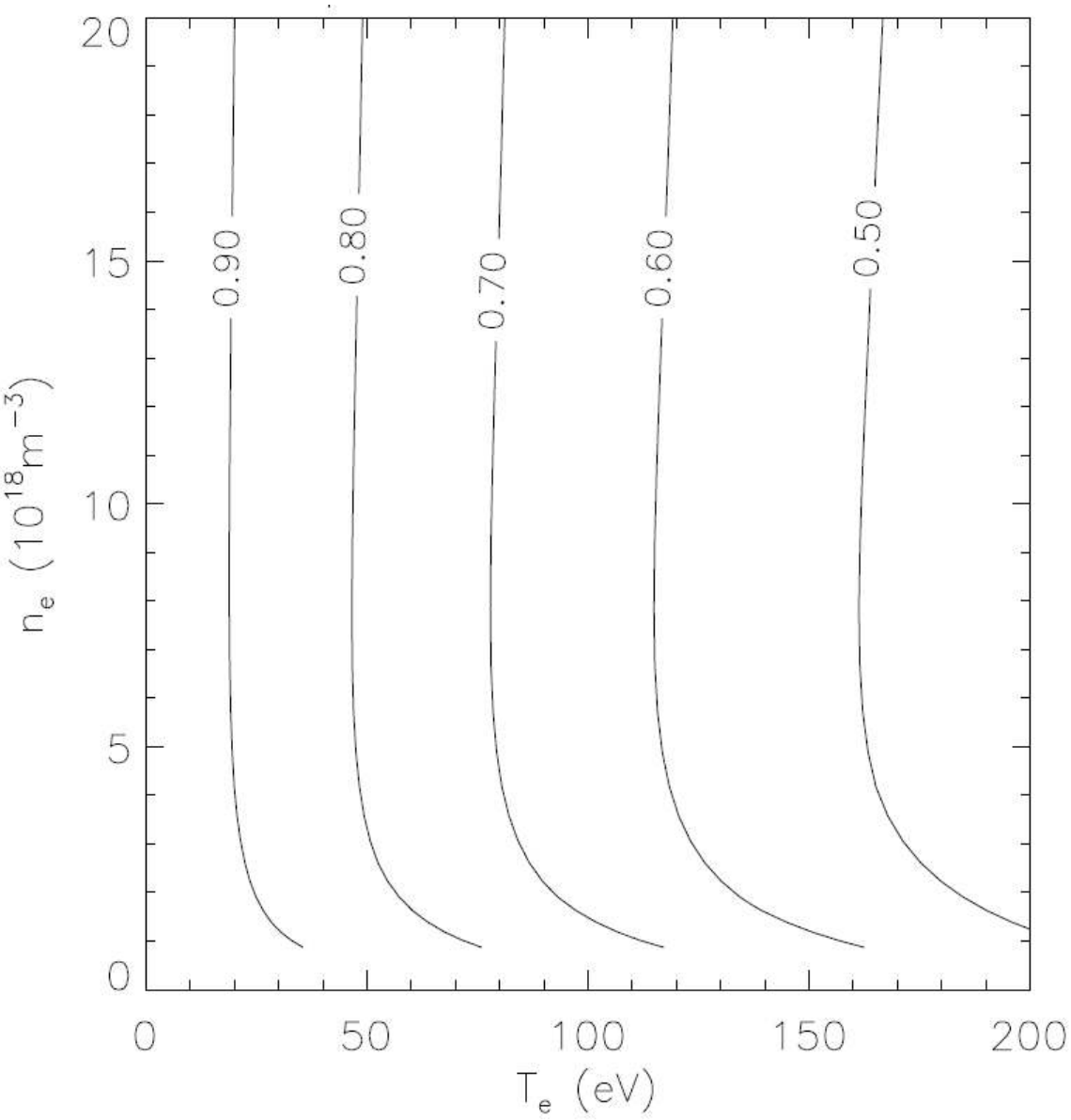
- the high n-model is not sufficiently refined for He
  (e.g. does not include spin system breakdown)

Problem with using CCC ionisation data for excited states:

- the latest data is significantly smaller than what's been used in the past $\Rightarrow$ drastic impact on triplet population

  I took in my cr-model Chibisov CX data and H data for n>3. Nice: CX for n>=3 is close to p+H(n) CX

Relative change of 3^3S population due to *CX losses*



CX can reduce 3^3S population by a factor 2

Loss of population by CX is the largest source of errors in the cr-model.

Note: error bar of CX data unknown

need CX-σ for 2^3S, 2^3P and high $n^{1,3}L$

After so many years, triplet population is still problematic.

Status of fast He beam model

ADAS codes should be rewritten (adf04 type excitation)

ADAS data should be updated

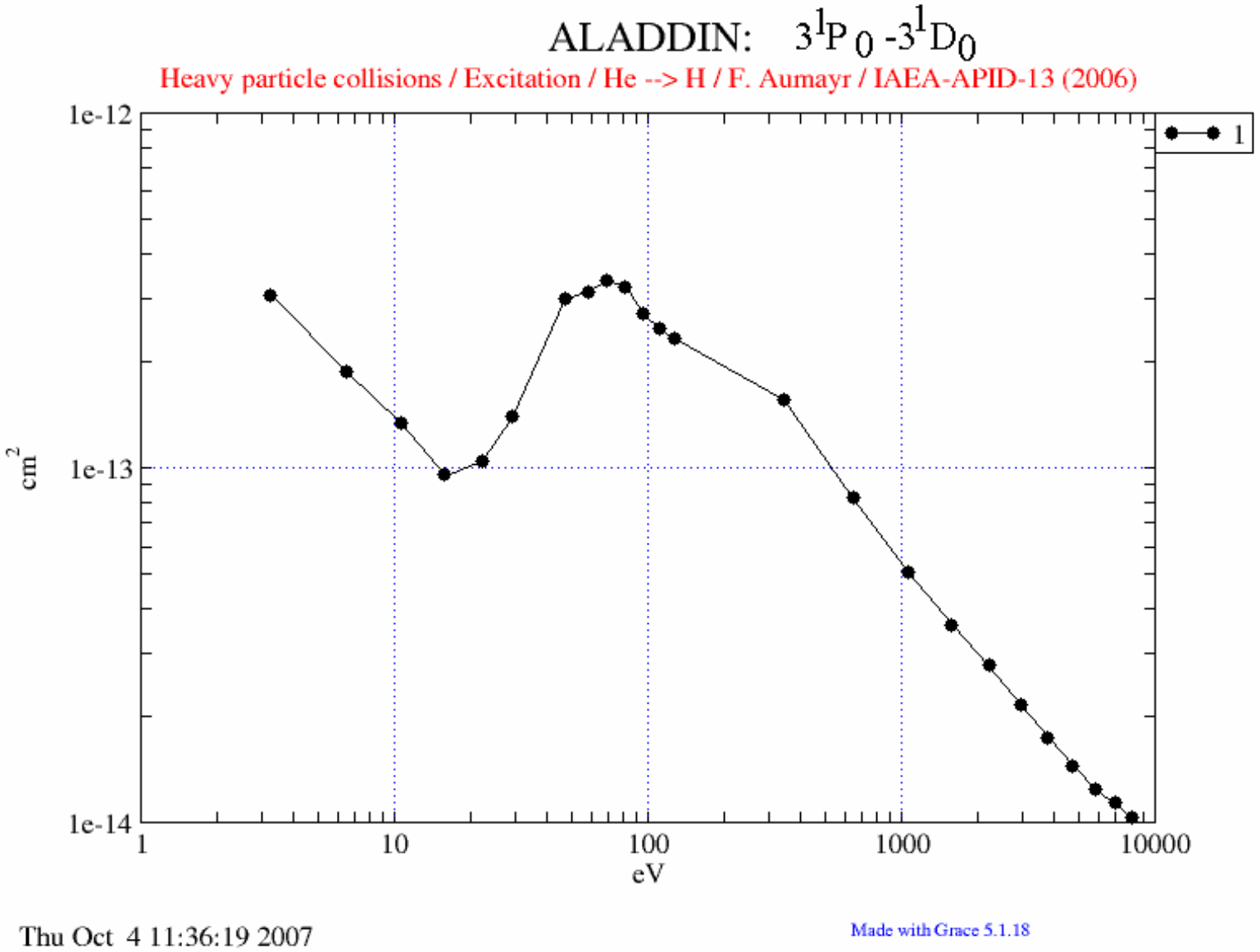
- high n-model should include spin system breakdown
- for JET beams ~40keV/amu and above, proton excitation, ionisation and CX data are not too bad (e-scaling for excitation is quite accurate)
- at E<<10keV oscillations of a factor ~3 have to be expected for the excitation

  $\Rightarrow$ need more accurate data

  but: Do we need data at these energies?

  What application ? What about ion collisions?

Example proton excitation cross section



Summary

Fast beam ADAS code should be rewritten. CX should be included into thermal He ADAS model.

Need some improvements for high n / spin system breakdown.

We need accurate excitation and CX data for both, thermal and fast beams.