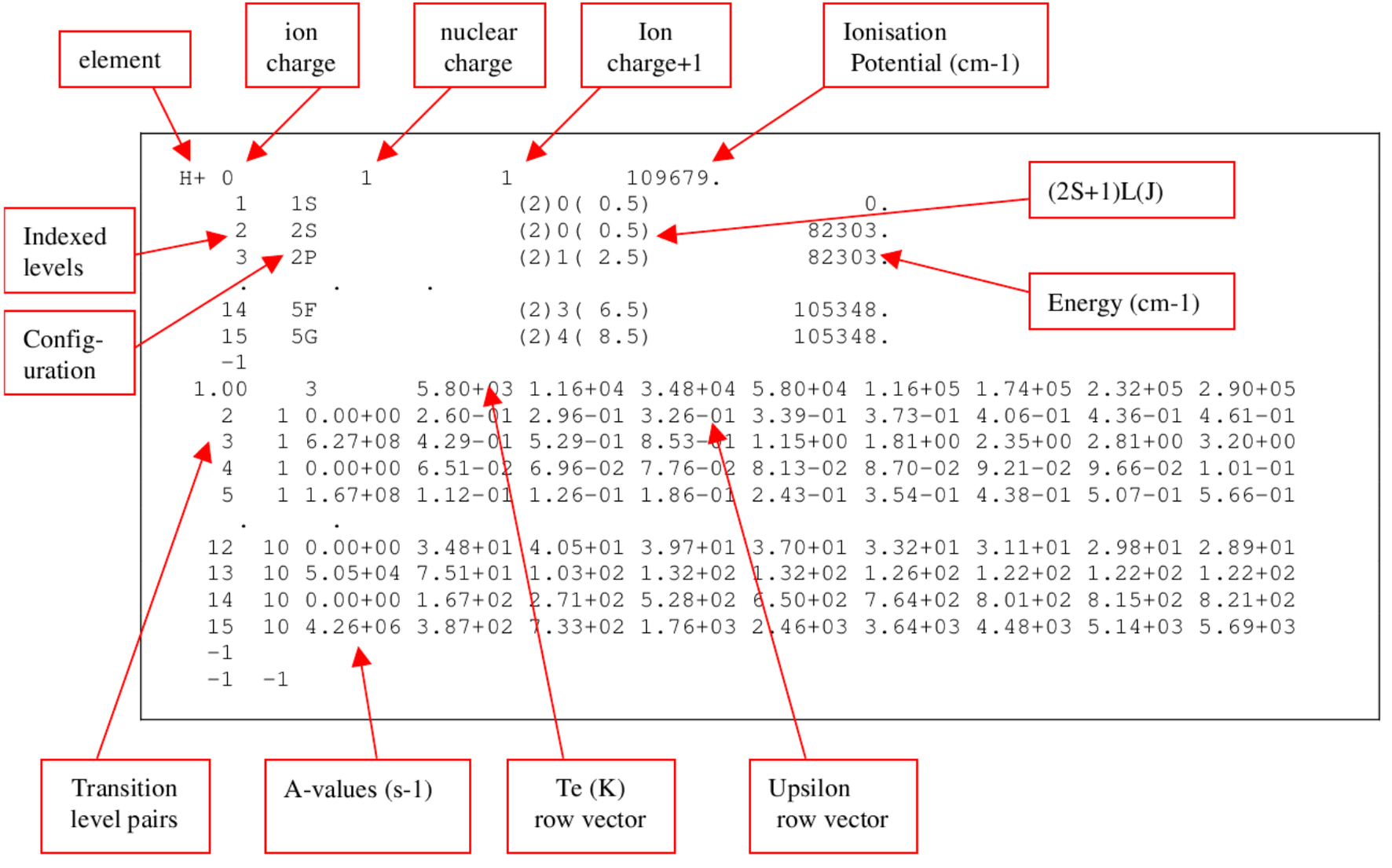
Report on OPEN-ADAS

Martin O'Mullane

The ADAS view of atomic data

- ADAS has focused its efforts in providing atomic data to model and interpret emission from hot, confined plasmas.
- Historical roots are in fusion (JET) and so are the bulk of the users.
- Has also been extensively applied to astrophysics.
- This background lead to the ADAS Project becoming a self-funding consortium of mostly fusion laboratories and its governance is by a steering committee of these members.
- OPEN-ADAS was championed (and funded) by IAEA to make the data more widely available.
- The delivery of this data is via the web but the data is returned as ADAS datasets rather than the more traditional individual cross sections.

ADAS data formats — *adf* — are precisely defined




```
H+ 0          1          1         109679.
   1   1S               (2)0( 0.5)              0.
   2   2S               (2)0( 0.5)          82303.
   3   2P               (2)1( 2.5)          82303.
   .    .      .
  14   5F               (2)3( 6.5)         105348.
  15   5G               (2)4( 8.5)         105348.
  -1
1.00    3       5.80+03 1.16+04 3.48+04 5.80+04 1.16+05 1.74+05 2.32+05 2.90+05
  2   1 0.00+00 2.60-01 2.96-01 3.26-01 3.39-01 3.73-01 4.06-01 4.36-01 4.61-01
  3   1 6.27+08 4.29-01 5.29-01 8.53-01 1.15+00 1.81+00 2.35+00 2.81+00 3.20+00
  4   1 0.00+00 6.51-02 6.96-02 7.76-02 8.13-02 8.70-02 9.21-02 9.66-02 1.01-01
  5   1 1.67+08 1.12-01 1.26-01 1.86-01 2.43-01 3.54-01 4.38-01 5.07-01 5.66-01
  .     .
 12  10 0.00+00 3.48+01 4.05+01 3.97+01 3.70+01 3.32+01 3.11+01 2.98+01 2.89+01
 13  10 5.05+04 7.51+01 1.03+02 1.32+02 1.32+02 1.26+02 1.22+02 1.22+02 1.22+02
 14  10 0.00+00 1.67+02 2.71+02 5.28+02 6.50+02 7.64+02 8.01+02 8.15+02 8.21+02
 15  10 4.26+06 3.87+02 7.33+02 1.76+03 2.46+03 3.64+03 4.48+03 5.14+03 5.69+03
 -1
 -1  -1
```

See http://www.adas.ac.uk/man/appxa-04.pdf

Reading ADAS for interactive manipulation

IDL is widely used in the fusion and astrophysics communities

```
IDL> read_adf40,file='adf40_ca_sn13.dat', fulldata=all

IDL> help, all, /st
   ESYM            STRING    'Sn'
   IZ0             LONG                50
   IS              LONG                13
   IS1             LONG                14
   NBLOCK          LONG                 2
   NPIX            LONG      Array[2]
   WAVE_MIN        DOUBLE    Array[2]
   WAVE_MAX        DOUBLE    Array[2]
   NTE             LONG      Array[2]
   TE              DOUBLE    Array[8, 2]
   NDENS           LONG      Array[2]
   DENS            DOUBLE    Array[4, 2]
   FPEC            DOUBLE    Array[256, 8, 4, 2]
   TYPE            STRING    Array[2]
```

ADAS data and discoverability

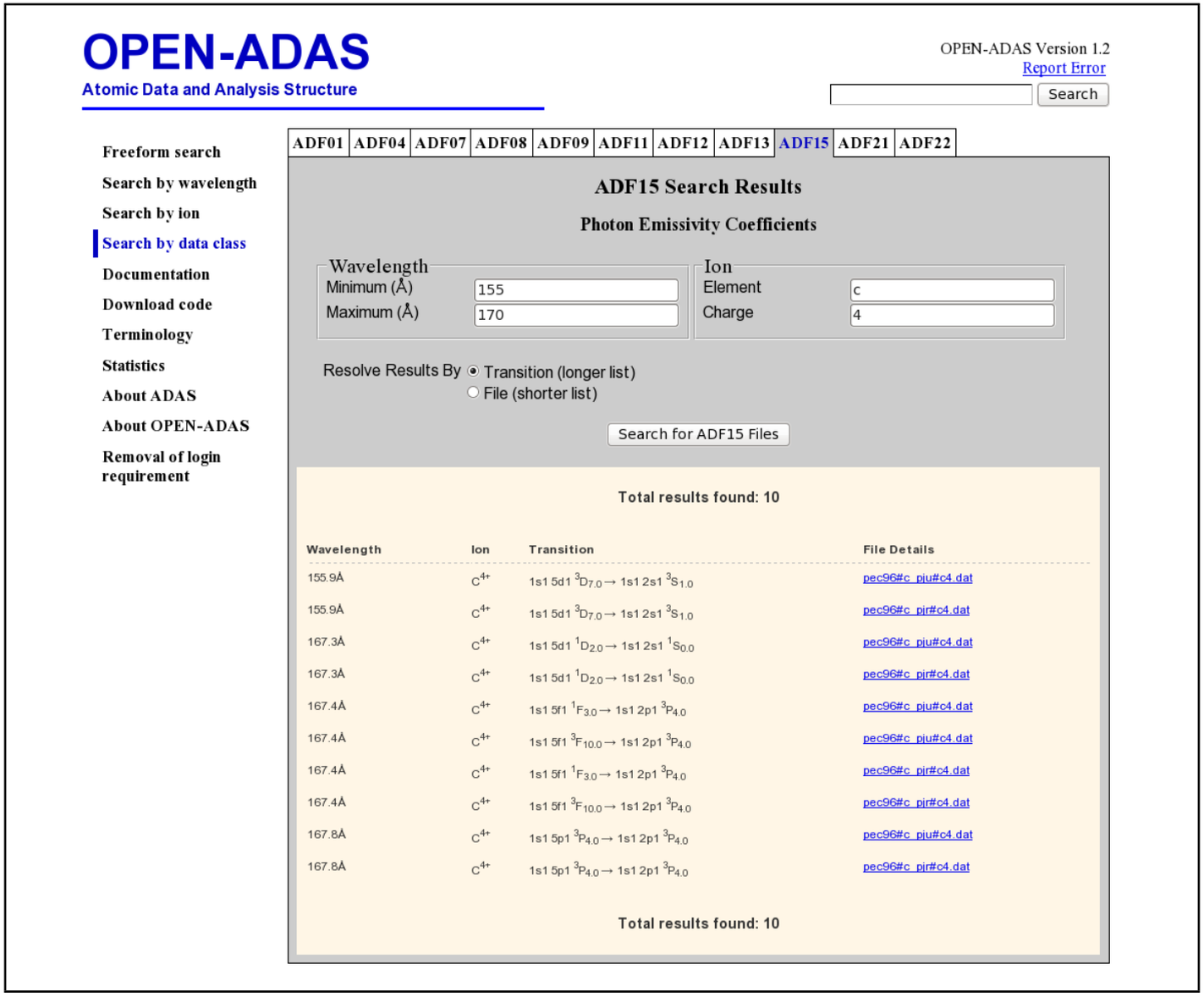
- ADAS data is highly structured and is routinely read into computer code structures and objects.
- Yet there is a perceived difficulty of finding stuff within ADAS.

OPEN-ADAS introduced ADAS *.tag* files. Consider the photon emissivity coefficient of CV or C^{+4}.

```
<adf15>
        <file>
                <type>ADF15</type>
                <filename>pec96#c_pju#c4.dat</filename>
                <directory>adf15/pec96#c</directory>
                <filesize>1003454</filesize>
                <tagged_on>2011-09-02</tagged_on>
                <tagged_by>Martin O'Mullane</tagged_by>
                <md5sum>0c9903fb467e4fd5de16561cc02ba5c6</md5sum>
        </file>
        <ion>
                <z0>6</z0>
                <z>4</z>
        </ion>
        <limits>
                <density>
                        <min units="cm-3">7.81E+05</min>
                        <max units="cm-3">7.81E+19</max>
                </density>
```

```
                <temperature>
                        <min units="eV">1.08E+00</min>
                        <max units="eV">6.46E+03</max>
                </temperature>
                <wavelength>
                        <min units="A">32.8</min>
                        <max units="A">2274.7</max>
                </wavelength>
        </limits>
        <contributors>
                <contributor>Martin O'Mullane</contributor>
        </contributors>
        <transitions>
                <transition>
                        <z>4</z>
                        <lambda units="A">40.7</lambda>
                        <upper>
                                <level>3</level>
                                <cfg>1S1 2S1</cfg>
                                <m>1</m>
                                <l>0</l>
                                <j>.0</j>
                        </upper>
                        <lower>
                                <level>1</level>
                                <cfg>1S2</cfg>
                                <m>1</m>
                                <l>0</l>
                                <j>.0</j>
                        </lower>
                        <type>Excitation</type>
                </transition>
        </transitions>
</adf15>
```

The *.tag* files index OPEN-ADAS searching



OPEN-ADAS

Atomic Data and Analysis Structure

OPEN-ADAS Version 1.2

Report Error

Search

- Freeform search
- Search by wavelength
- Search by ion
- Search by data class
- Documentation
- Download code
- Terminology
- Statistics
- About ADAS
- About OPEN-ADAS
- Removal of login requirement

ADF01 | ADF04 | ADF07 | ADF08 | ADF09 | ADF11 | ADF12 | ADF13 | ADF15 | ADF21 | ADF22

ADF15 Search Results

Photon Emissivity Coefficients

Wavelength: Minimum (Å) 155; Maximum (Å) 170

Ion: Element c; Charge 4

Resolve Results By: (•) Transition (longer list); ( ) File (shorter list)

Search for ADF15 Files

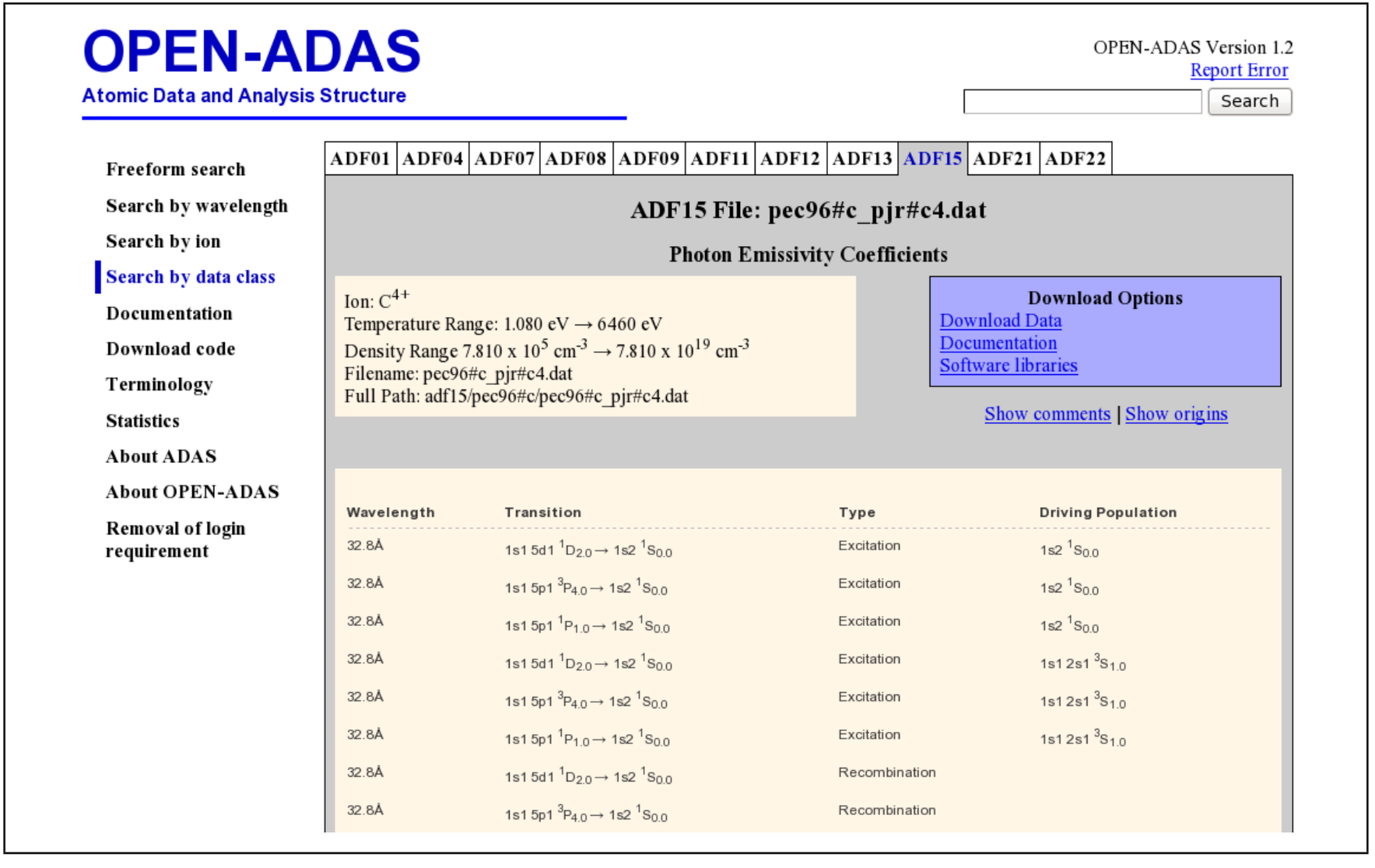
Total results found: 10

Wavelength	Ion	Transition	File Details
155.9Å	C^{4+}	$1s^1\,5d^1\,{}^3D_{7.0} \rightarrow 1s^1\,2s^1\,{}^3S_{1.0}$	pec96#c_pju#c4.dat
155.9Å	C^{4+}	$1s^1\,5d^1\,{}^3D_{7.0} \rightarrow 1s^1\,2s^1\,{}^3S_{1.0}$	pec96#c_pjr#c4.dat
167.3Å	C^{4+}	$1s^1\,5d^1\,{}^1D_{2.0} \rightarrow 1s^1\,2s^1\,{}^1S_{0.0}$	pec96#c_pju#c4.dat
167.3Å	C^{4+}	$1s^1\,5d^1\,{}^1D_{2.0} \rightarrow 1s^1\,2s^1\,{}^1S_{0.0}$	pec96#c_pjr#c4.dat
167.4Å	C^{4+}	$1s^1\,5f^1\,{}^1F_{3.0} \rightarrow 1s^1\,2p^1\,{}^3P_{4.0}$	pec96#c_pju#c4.dat
167.4Å	C^{4+}	$1s^1\,5f^1\,{}^3F_{10.0} \rightarrow 1s^1\,2p^1\,{}^3P_{4.0}$	pec96#c_pju#c4.dat
167.4Å	C^{4+}	$1s^1\,5f^1\,{}^1F_{3.0} \rightarrow 1s^1\,2p^1\,{}^3P_{4.0}$	pec96#c_pjr#c4.dat
167.4Å	C^{4+}	$1s^1\,5f^1\,{}^3F_{10.0} \rightarrow 1s^1\,2p^1\,{}^3P_{4.0}$	pec96#c_pjr#c4.dat
167.8Å	C^{4+}	$1s^1\,5p^1\,{}^3P_{4.0} \rightarrow 1s^1\,2p^1\,{}^3P_{4.0}$	pec96#c_pju#c4.dat
167.8Å	C^{4+}	$1s^1\,5p^1\,{}^3P_{4.0} \rightarrow 1s^1\,2p^1\,{}^3P_{4.0}$	pec96#c_pjr#c4.dat

Total results found: 10

OPEN-ADAS delivery

However it is the complete ADAS file that is returned when downloaded.



OPEN-ADAS

Atomic Data and Analysis Structure

OPEN-ADAS Version 1.2

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ADF01 | ADF04 | ADF07 | ADF08 | ADF09 | ADF11 | ADF12 | ADF13 | ADF15 | ADF21 | ADF22

ADF15 File: pec96#c_pjr#c4.dat

Photon Emissivity Coefficients

Ion: C^{4+}
Temperature Range: 1.080 eV → 6460 eV
Density Range 7.810 x 10^{5} cm^{-3} → 7.810 x 10^{19} cm^{-3}
Filename: pec96#c_pjr#c4.dat
Full Path: adf15/pec96#c/pec96#c_pjr#c4.dat

Download Options
Download Data
Documentation
Software libraries

Show comments | Show origins

Wavelength	Transition	Type	Driving Population
32.8Å	$1s1\,5d1\ ^1D_{2.0} \rightarrow 1s2\ ^1S_{0.0}$	Excitation	$1s2\ ^1S_{0.0}$
32.8Å	$1s1\,5p1\ ^3P_{4.0} \rightarrow 1s2\ ^1S_{0.0}$	Excitation	$1s2\ ^1S_{0.0}$
32.8Å	$1s1\,5p1\ ^1P_{1.0} \rightarrow 1s2\ ^1S_{0.0}$	Excitation	$1s2\ ^1S_{0.0}$
32.8Å	$1s1\,5d1\ ^1D_{2.0} \rightarrow 1s2\ ^1S_{0.0}$	Excitation	$1s1\,2s1\ ^3S_{1.0}$
32.8Å	$1s1\,5p1\ ^3P_{4.0} \rightarrow 1s2\ ^1S_{0.0}$	Excitation	$1s1\,2s1\ ^3S_{1.0}$
32.8Å	$1s1\,5p1\ ^1P_{1.0} \rightarrow 1s2\ ^1S_{0.0}$	Excitation	$1s1\,2s1\ ^3S_{1.0}$
32.8Å	$1s1\,5d1\ ^1D_{2.0} \rightarrow 1s2\ ^1S_{0.0}$	Recombination	
32.8Å	$1s1\,5p1\ ^3P_{4.0} \rightarrow 1s2\ ^1S_{0.0}$	Recombination	

Data classes supplied in OPEN-ADAS

OPEN-ADAS is designed to appeal to both plasma modellers and those interested in the detailed atomic physics.

OPEN-ADAS

Atomic Data and Analysis Structure

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Statistics

Data class	Description	Number of files	Total Size
ADF01	Charge Exchange Cross Sections	127	2 MB
ADF04	Resolved Specific Ion Data Collections	1675	3 GB
ADF07	Electron Impact Ionisation Coefficients	72	645.6 kB
ADF08	Radiative Recombination Coefficients	100	482.5 kB
ADF09	Resolved Dielectronic Recombination Coefficients	1622	1.1 GB
ADF11	Iso-nuclear Master Files	796	111.2 MB
ADF12	Charge Exchange Effective Emission Coefficients	167	4.5 MB
ADF13	Ionisation Per Photon Coefficients	153	35.2 MB
ADF15	Photon Emissivity Coefficients	551	102 MB
ADF21	Effective Beam Stopping/excitation Coefficients	220	1.8 MB
ADF22	Effective Beam Emission/population Coefficients	406	3.4 MB

Extension of data supplied via OPEN-ADAS

ADF23: state selective electron impact ionisation coefficients

ADF24: state selective charge transfer cross-sections

ADF25: driver data-sets for ADAS204 calculations

ADF26: bundle-n and bundle-nl populations of excited states in beams

ADF27: driver data-sets for ADAS701 calculations

ADF28: driver data-sets for ADAS702 calculations

ADF31: feature files for satellite line spectral simulation

ADF34: driver data-sets for ADAS801 calculations

ADF35: spectral filter data

ADF37: non-Maxwellian distribution function files

ADF38: Seaton - opacity photo-excitation

ADF39: Seaton - opacity - photo-ionisation

ADF40: Envelope feature photon emissivity coefficients

ADF42: driver data-sets for ADAS810 calculations

ADF43: GTN photon emissivity functions

ADF44: F_GTN envelope feature emissivity functions

ADF46: Driver data sets for BBGP for dielectronic recombination

ADF48: State selective radiative recombination coefficients

ADF49 : Universal z-scaled bundle-n and bundle-nl charge exchange cross-sections

OPEN-ADAS and the wider world

OPEN-ADAS is beginning to appear in citations It is seen as a Google Scholar resource and is appearing in citations.

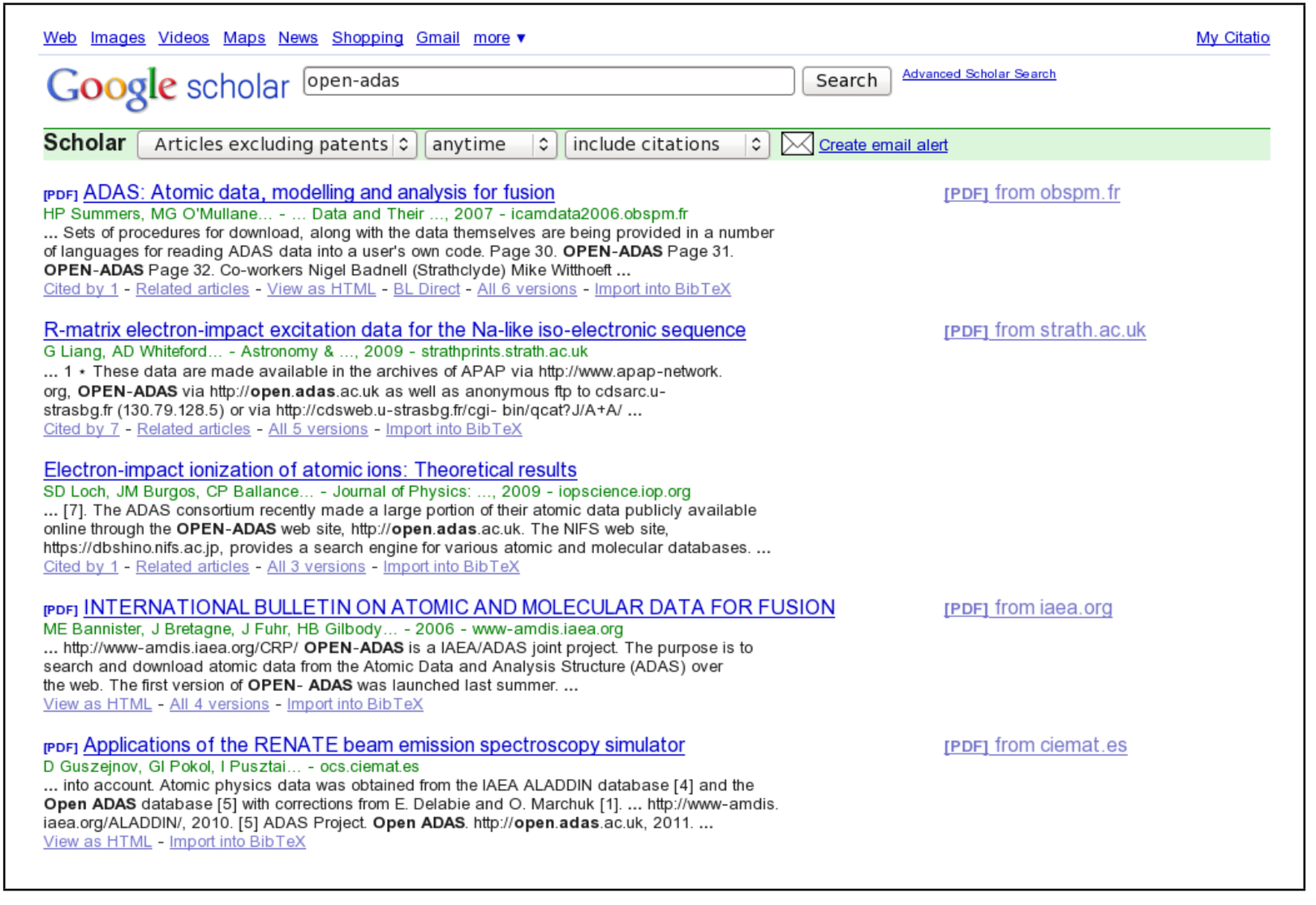
[30] Goto M 2003 *J. Quant. Spectrosc. Radiat. Transfer* **76** 331
[31] Nakano T, Kubo H, Asakura N, Shimizu K and Higashijima S 2004 *J. Plasma Fusion Res.* **80** 500
[32] Nakano T, Kubo H, Asakura N, Shimizu K, Kawashima H and Higashijima S 2009 *J. Nucl. Mater.* **390–391** 255
[33] OPEN-ADAS Version 1.0, http://open.adas.ac.uk
[34] Terry J L, Lipschultz B, Pigarov A Yu, Krasheninnikov S I, LaBombard B, Lumma D, Ohkawa H, Pappas D and Umansky M 1998 *Phys. Plasmas* **5** 1759
[35] Meigs A G, Fundamenski W, Jupen C, Larsen A, Loch S, O'Mullane M and Summers H 2000 *27th EPS Conf. on Controlled Fusion and Plasma Physics* (Budapest, Hungary) P3 121, https://fusion.gat.com/conferences/meetings/eps00/pdf/p3_121.pdf

A Iwamae et al, Plasma Phys. Control. Fusion, **53**(2011), 045005

- It would be good if this is seen as a way to give greater recognition to the people who generated the data in ADAS.
- We will implement a URI to allow reference to a specific dataset.

OPEN-ADAS and the wider web

OPEN-ADAS is seen as a Google Scholar resource — without lobbying!



Web Images Videos Maps News Shopping Gmail more ▾ My Citatio

Google scholar open-adas Search Advanced Scholar Search

Scholar Articles excluding patents anytime include citations Create email alert

[PDF] ADAS: Atomic data, modelling and analysis for fusion [PDF] from obspm.fr
HP Summers, MG O'Mullane... - ... Data and Their ..., 2007 - icamdata2006.obspm.fr
... Sets of procedures for download, along with the data themselves are being provided in a number of languages for reading ADAS data into a user's own code. Page 30. **OPEN-ADAS** Page 31. **OPEN-ADAS** Page 32. Co-workers Nigel Badnell (Strathclyde) Mike Witthoeft ...
Cited by 1 - Related articles - View as HTML - BL Direct - All 6 versions - Import into BibTeX

R-matrix electron-impact excitation data for the Na-like iso-electronic sequence [PDF] from strath.ac.uk
G Liang, AD Whiteford... - Astronomy & ..., 2009 - strathprints.strath.ac.uk
... 1 • These data are made available in the archives of APAP via http://www.apap-network.org, **OPEN-ADAS** via http://**open.adas**.ac.uk as well as anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsweb.u-strasbg.fr/cgi- bin/qcat?J/A+A/ ...
Cited by 7 - Related articles - All 5 versions - Import into BibTeX

Electron-impact ionization of atomic ions: Theoretical results
SD Loch, JM Burgos, CP Ballance... - Journal of Physics: ..., 2009 - iopscience.iop.org
... [7]. The ADAS consortium recently made a large portion of their atomic data publicly available online through the **OPEN-ADAS** web site, http://**open.adas**.ac.uk. The NIFS web site, https://dbshino.nifs.ac.jp, provides a search engine for various atomic and molecular databases. ...
Cited by 1 - Related articles - All 3 versions - Import into BibTeX

[PDF] INTERNATIONAL BULLETIN ON ATOMIC AND MOLECULAR DATA FOR FUSION [PDF] from iaea.org
ME Bannister, J Bretagne, J Fuhr, HB Gilbody... - 2006 - www-amdis.iaea.org
... http://www-amdis.iaea.org/CRP/ **OPEN-ADAS** is a IAEA/ADAS joint project. The purpose is to search and download atomic data from the Atomic Data and Analysis Structure (ADAS) over the web. The first version of **OPEN- ADAS** was launched last summer. ...
View as HTML - All 4 versions - Import into BibTeX

[PDF] Applications of the RENATE beam emission spectroscopy simulator [PDF] from ciemat.es
D Guszejnov, GI Pokol, I Pusztai... - ocs.ciemat.es
... into account. Atomic physics data was obtained from the IAEA ALADDIN database [4] and the **Open ADAS** database [5] with corrections from E. Delabie and O. Marchuk [1]. ... http://www-amdis.iaea.org/ALADDIN/, 2010. [5] ADAS Project. **Open ADAS**. http://**open.adas**.ac.uk, 2011. ...
View as HTML - Import into BibTeX

Loss of metrics

Until June 2011 OPEN-ADAS:

- Worked without problems except for minor power outages.
- A steady increase in new users with a wide geographic spread.
- Downloads and file views increased.

Just when one thinks that all is going well....

- On 2nd June the OPEN-ADAS website, but not the server, was hacked using a MySQL injection attack.
- Logs showed a large increase in such attacks for the following few weeks.
- June 16, 2011 — hard disk failure on OPEN-ADAS server.

What now for OPEN-ADAS?

Our response to the intrusion:

- A new server was commissioned within a few days.
- Removed the requirement to register in order to download data.
- OPEN-ADAS was off the internet for 8 weeks.
- We have lost the ability to know who our users are but without more resources it the most pragmatic solution.

The future:

- We intend to keep OPEN-ADAS running.
- Investigate a mirroring arrangement with Auburn.
- Explore XSAMS as an optioanl, additional output option.
- Synchronize OPEN-ADAS with ADAS — perhaps a 1–4 month lag.
- Add new, not necessarily fusion, data classes.