



Data exchange and management for electron and ion collisional processes in plasmas: the LXCat project

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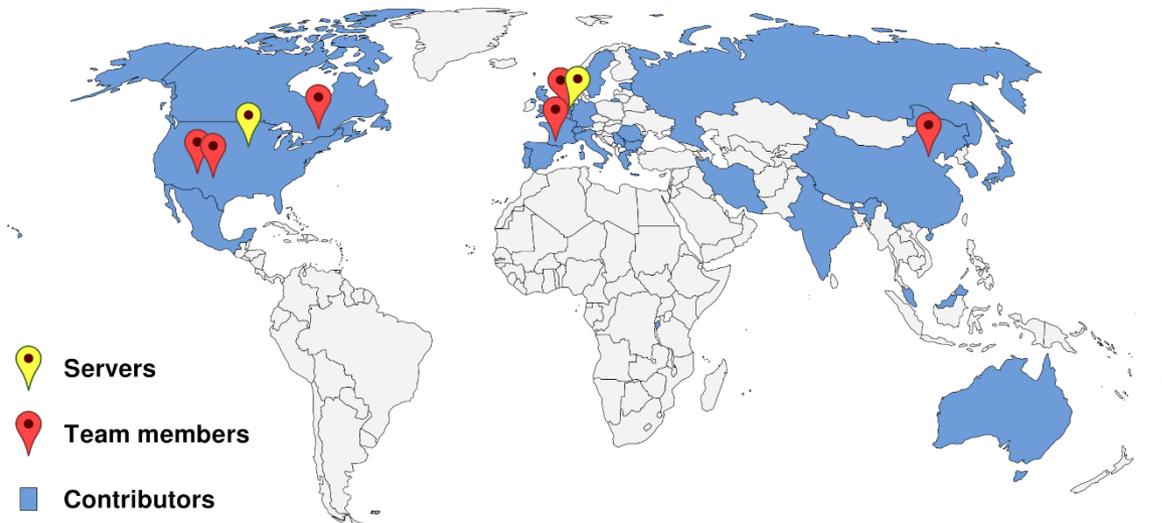
Contributors and usage of LXCat



More than **50 contributors** from over **15** different **countries**.

→ Various **forms of contribution**: creation of individual database, website, technical support, outreach, mirror server,...

Circa **120** unique **visitors** per day and **50 000 visits** per year with **1700 citations** of „LXCat“ in papers (2009-2022 period).



The LXCat project (2009 - present)



LXCat: ELECTron (and ion) SCATtering

Electron + neutral
cross sections / oscillator strengths/
swarm parameters

Ion + neutral
cross sections / interaction potentials /
swarm parameters

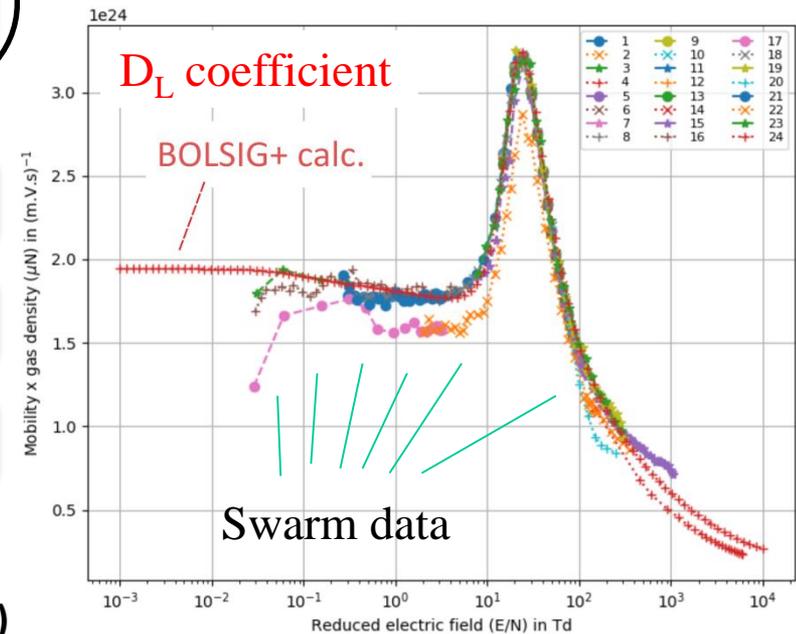
Plasma-surface interactions

Plasma chemistry

Radiation

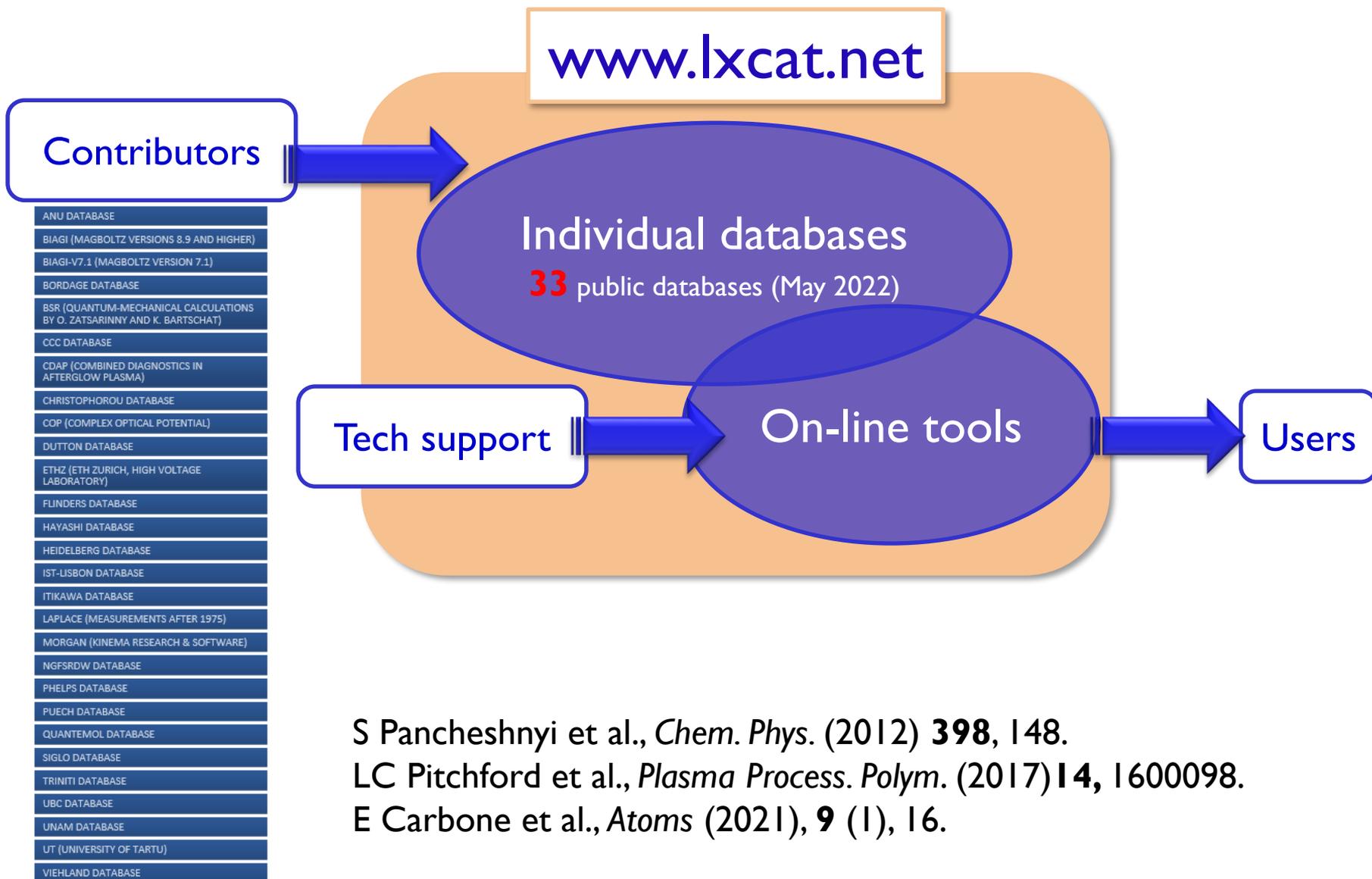
Purpose of LXCat:

- Curation
- Comparison
- Calculation



c)

LXCat structure – databases & online tools



S Pancheshnyi et al., *Chem. Phys.* (2012) **398**, 148.

LC Pitchford et al., *Plasma Process. Polym.* (2017) **14**, 1600098.

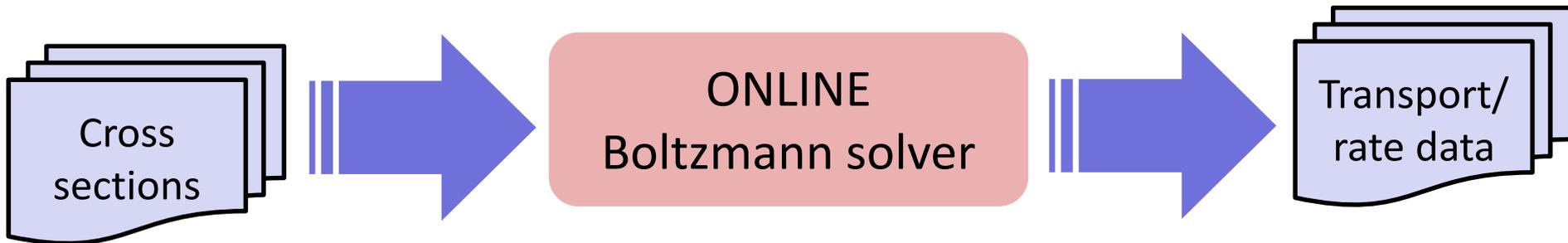
E Carbone et al., *Atoms* (2021), **9** (1), 16.

Scattering cross sections => transport & rate data



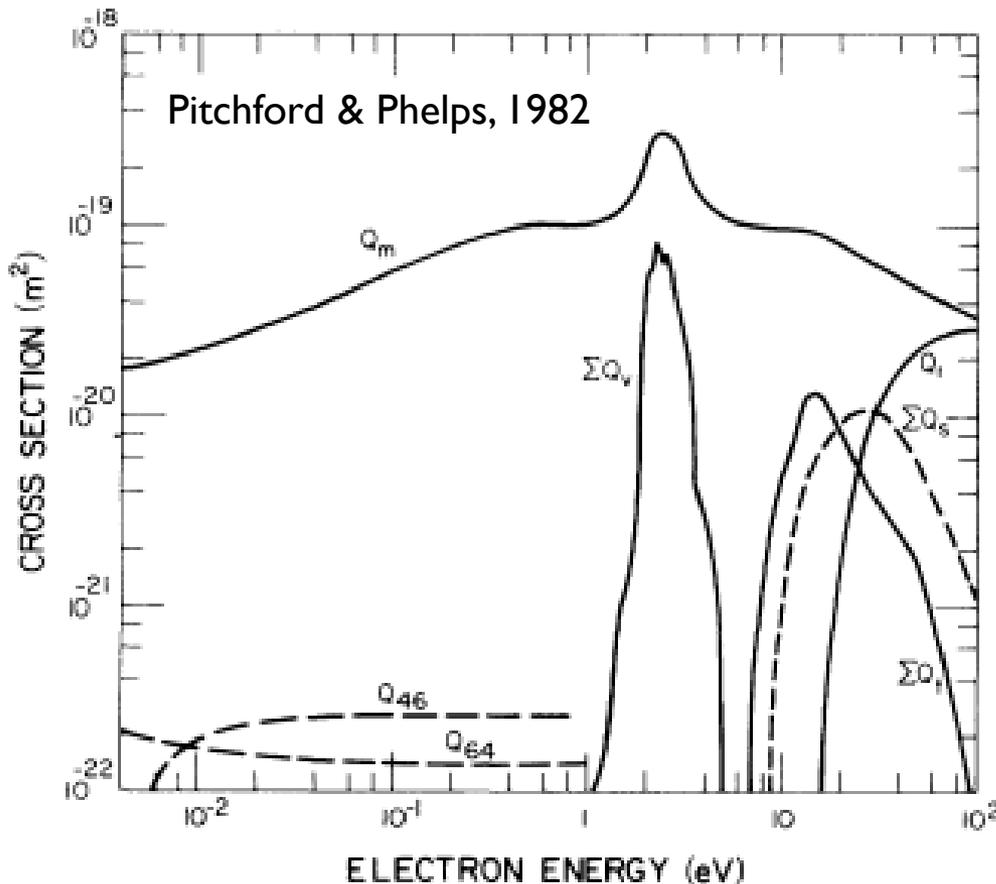
For the electron component....

the emphasis in LXCat is on the cross section data. These are either used directly in models or are used to calculate transport and rate coefficients vs E/N or $\langle e \rangle$.



“Complete” set of cross sections : includes all major electron momentum and energy loss processes. When used as input in a Boltzmann equation solver, yields swarm/transport coefficients vs. E/N (or vs. mean electron energy) in agreement with experiment.

Input data required for Boltzmann equation solutions



Types of collisions:

- **Elastic**

Recoil energy loss, momentum transfer ($Q_{m,el}$)

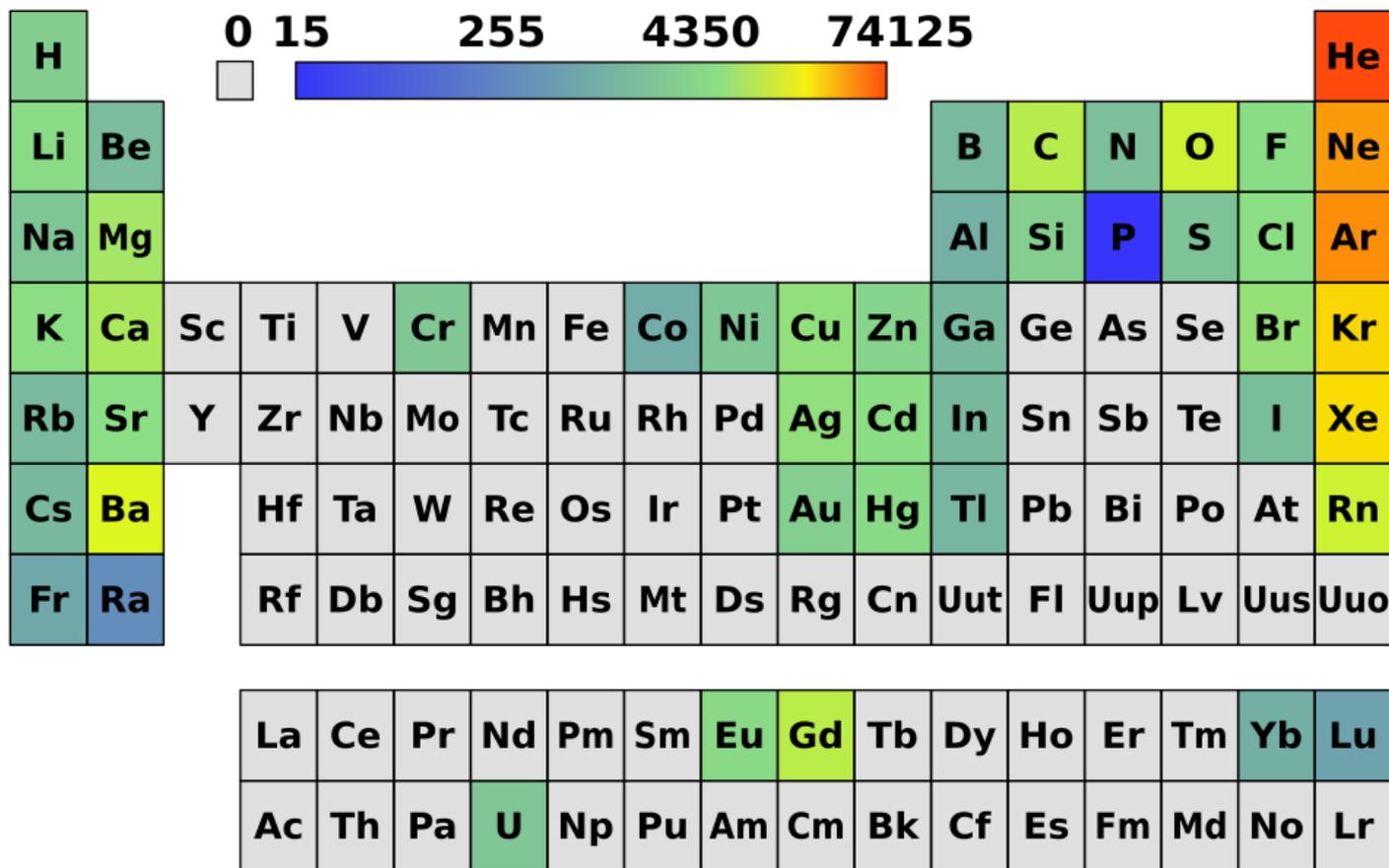
- **Inelastic**

Discrete energy losses due to excitation of rotational, vibrational and electronic states ($Q_{k,T}$)

- **Ionization**

Two electrons exit the collision event ($Q_{i,T}$, energy sharing)

The LXCat project: some statistics



- Quite inclusive representation of the elements of the periodic table (not only noble gases!)

Complete sets of e-/neutral cross sections available on



...for electron scattering in **COLD gases**

Definition: A complete set of cross sections consists of elastic momentum transfer, and total cross sections for the processes of ionization, attachment and excitation. Complete sets of cross sections are needed as input to a Boltzmann equation solver to determine the electron or ion energy distribution function.

Atomic gases

Ar, C, Cu, H, He, Hg, Kr, Mg, N, Ne, Na, O, Xe

Diatomic gases

CH, CO, Cl₂, D₂, F₂, H₂, HCl, N₂, NO, O₂

Polyatomic gases

C₂H₂, C₂H₄, C₂H₆, C₃H₆, C₃H₈, CCl₂F₂, CCl₄, CF₄, CH₄, CH₃, CH₄,
CHF₃, CO₂, H₂O, N₂O, SF₆, SO₂, Si₂H₆, Si(CH₃)₄, SiH₄



To be continued...

Thank you for your attention!

More information about history of LXCat:

E Carbone et al., *Atoms* (2021), **9** (1), 16.

And now the future follows!

LXCat policy



1) Anyone willing to contribute data to the site can request a password and set up a database. => Data for the same processes can be listed in multiple databases. **LXCat does not recommend data** (see discussion in E Carbone et al., *Atoms* (2021), 1, 16).

2) The site is **open access** and data can be downloaded without registering or paying a fee, but **proper referencing is essential** for the survival of LXCat.

Required reference format:

[database name], www.lxcat.net, [retrieval date]

+ List all references given in the database for the species

3. **Databases are dynamic**. Contributors make changes as new data become available or when corrections are needed. **Time machine** allows retrieving database at any given time in the past.