UCL

Applications and achievements of CCP-SAS

Stephen J. Perkins

Structural and Molecular Biology, Darwin Building, UCL

CCP SAS
A Joint EPSRC-NSF Software Project

CCP-SAS

• Paul Butler (PI)

We started in 2013

• Jianhan Chen
Kansas State University
• Joseph Curtis
NIST Center for Neutron Research
• Tom Irving
Advanced Photon Source
+ other collaborators

Grant No.
SI2/CHE-1265821

An SI² cyberinfrastructure project addressing Grand Challenges in the Chemical Sciences

CCP SAS
A Joint EPSRC-NSF Software Project
http://www.ccpsas.org

Collaborative Computational Project for advanced analyses of structural data in chemical biology and soft condensed matter

Grant No.
EP/K039121/1

EPSRC

• Stephen Perkins (PI)
University College London
• David Barlow
Kings College London
• Karen Edler
University of Bath
• Richard Heenan & Steve King
ISIS Pulsed Neutron & Muon Source
• David Scott
Nottingham University
• Nick Terrill
Diamond Light Source
+ other collaborators

UK Collaborative Computational Projects
In 2017, we have 17 CCPs in the UK:

CCP SAS
A Joint EPSRC-NSF Software Project

CCP NC
Collaborative Computational Project for NMR Crystallography

Biology

CCPN

CCP-EM

CCP4

CCP4 on-line

CCP PET-MR

CoDiMa

CCPBioSim

CCP Computational Electronic Structure of Condensed Matter

CCPi Tomographic Imaging

CCP5

Soft matter

ASEArch

CCPForge

CCP-Plasma

CCPQ
Collaborative Computational Project Q

CCP-WSI
A Collaborative Computational Project in Wave Structure Interaction

Funding: EPSRC, MRC, STFC, BBSRC, CECAM, EU

Usage of SASSIE-web on the HPC at Tennessee, USA

beta period:
June 1, 2015 to May 20, 2016 (8496 hours)

273 total registered users (~200 “active”):

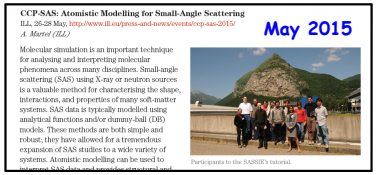
14492 jobs (avg = 53, max = 1969)

941 projects (avg = 3.4, max = 233)

>16765 CPU hours (avg = 62, max = 4218)

~ 2 TB user data storage upgraded to 24 TB total

Started in 2013 – talks and tutorials reaching out to France, Germany and Australia in 2015, Spain in 2016, India and Pakistan in 2017……together with training courses in Europe and the USA …next is India.

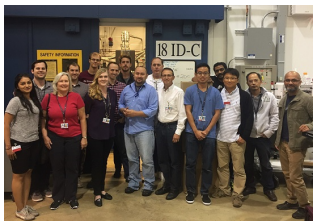

CCP-SAS: Atomistic Modelling for Small-Angle Scattering
ILL, 26-28 May, http://www.ill.eu/press-and-news/events/ccp-sas-2015/
A. Martel (ILL)

May 2015

Molecular simulation is an important technique for analysing and interpreting molecular phenomena across many disciplines. Small-angle scattering (SAS) using X-ray or neutron sources is a valuable method for characterising the shape, interactions, and properties of many soft-matter systems. SAS data is typically modelled using analytical functions and/or dummy-ball (DB) models. These methods are both simple and robust; they have allowed for a tremendous expansion of SAS studies to a wide variety of systems. Atomistic modelling can be used to

Participants to the SASSIE's tutorial.

SASSIE CCP-SAS Workshop, The Cosener's House, ISIS Pulsed Neutron & Muon Source and Diamond Light Source, UK - Jan 23-25 2017.



Atomistic Modeling of Small-Angle Scattering Data Using SASSIE-web, APS, Argonne National Laboratory, USA - Sep 21-23 2016.

CCP SAS

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1. CCP-SAS background
2. Computing strategy
3. Example applications

Starting point for CCP-SAS are the world-class multiuser facilities for scattering – such as these in Europe:

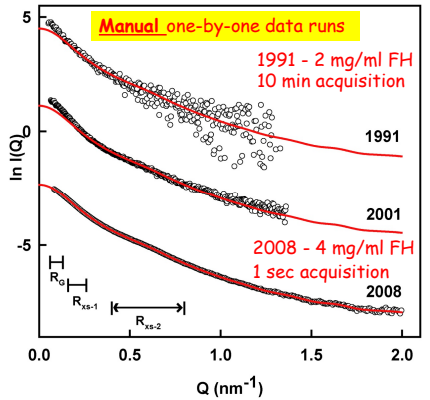
ILL neutrons in Grenoble, France

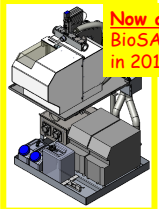
ISIS neutrons at Harwell, UK

And also for analytical ultracentrifugation (absorbance, interference, fluorescence optics).

Much better data sets: complement Factor H (FH)

Acquisition times dropped from 600 sec to 1 sec - and now all automated.



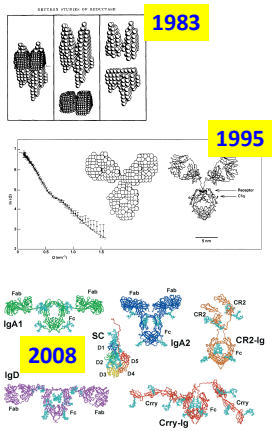


Steve's short history of SAS modelling

SANS modelling at EMBL/ILL was first attempted with small spheres for a membrane protein starting from EM models in 1983

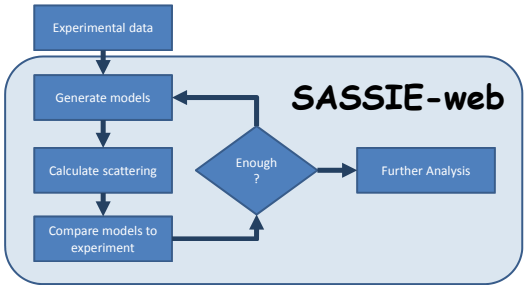
SANS modelling at ISIS was developed for IgG antibodies using crystal structures in 1995.

SERC grant funding awarded to develop SCT-SCTPL. This was used to determine 77 atomistic structures from SAXS and SANS data during 1998-2015, including antibodies. Structures were deposited in the PDB.



Aims of CCP-SAS

We aim to develop an easy-to-use open-source modelling package that enables users to generate physically accurate atomistic models, calculate scattering profiles and compare results to experimental scattering data sets in a single accessible web-based software suite.



History of modelling – why CCP-SAS?

SCT-SCTPL at UCL was not publically released, user-unfriendly, closed source, and needed updating/extending. But this was used to determine 77 atomistic structures, starting with our first paper in 1998.

SASSIE at NIST was developed as a user facility to handle atomistic modelling. This started in 2004 with the first prototype, and the first paper appeared in 2007.

By combining SCT-SCTPL and SASSIE in a joint UK-USA collaboration, we obtained EPSRC-NSF funding in 2013. The project is termed "CCP-SAS".

We set out to develop a comprehensive and broad physically-accurate atomistic modelling package for SAS and other data sets for the community.

CCP SAS

A Joint EPSRC-NSF Software Project

1. CCP-SAS background
2. **Computing strategy**
3. Example applications

CCP-SAS between 2013-2017

Programming Deliverables by Year during four years

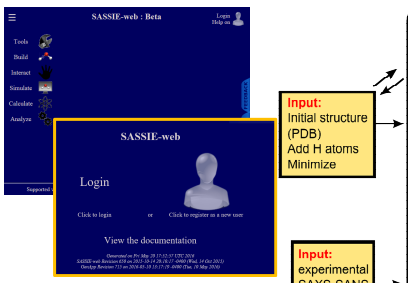
[Year 1] Web prototype ("SASSIE web") and alpha testing

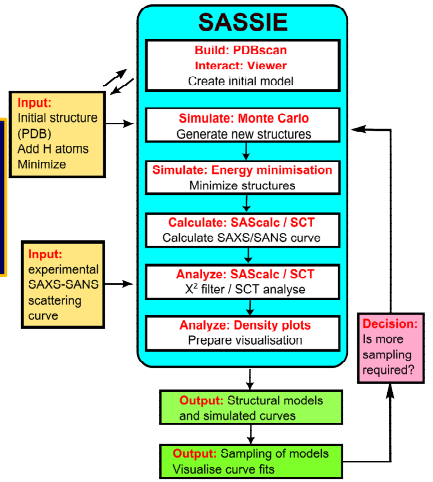
[Year 2] Web released, HPC back-end prototype, and alpha testing

[Year 3] Disseminate HPC beta to international centres; incorporate contributed community code

[Year 4] Advance GPU implementation, soft-matter builder, polish, HPC release

Home page at https://sassie-web.chem.utk.edu/sassie2/





SASSIE has these:

Tools to build structures
Easy access to MC / MD
Workflow connection
Modular
Handle long jobs
Constraints (eg: NMR)
Open source

CCP SAS

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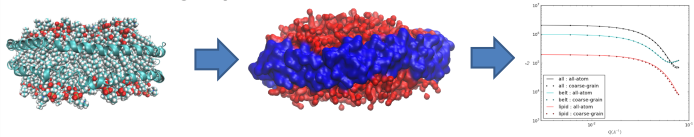
1. CCP-SAS background
2. Computing strategy
3. **Example applications**

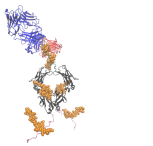
Applications are broad ranging

SOFT MATTER – eg: Polymer + Nanodisc

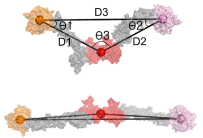


BIOLOGY AND BIOTECHNOLOGY

eg: Antibody + Glycans



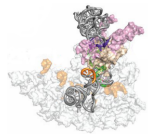
G K Hui *et al.*, Biochem. J. (2015), DOI: 10.1042/BJ201506



eg: Complement

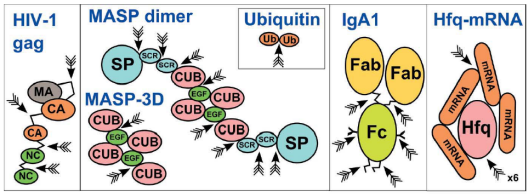
R. Nan *et al.*, Strructure. (2017), DOI 10.1016/j.str.2016.12.014

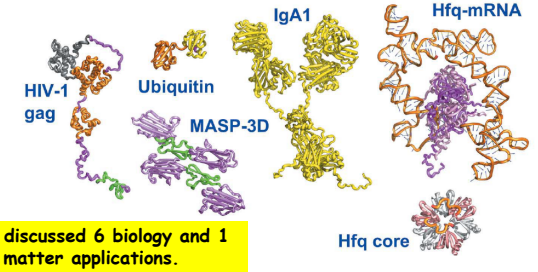
eg: Hfq + RNA



Y Peng *et al.*, *PNAS* (2014), DOI: 10.1073/pnas.14101 14111

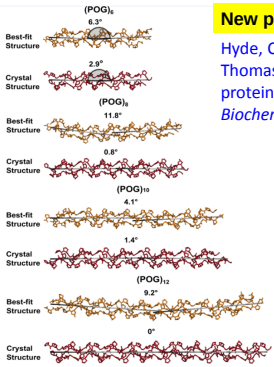
Review of CCP-SAS with 14 co-authors to follow the Berlin SAS meeting in September 2015: Perkins et al. (2016) J. Appl. Cryst. 49, 1861-1875.





Papers
2013 – 7
2014 – 10
2015 – 10
2016 – 13
2017 – 2+

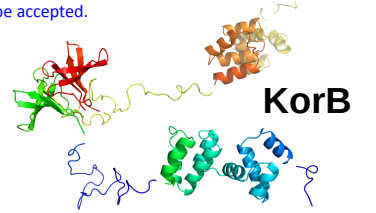
This discussed 6 biology and 1 soft matter applications.



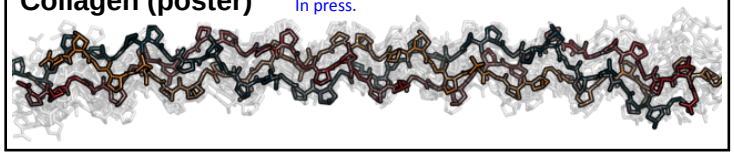
Collagen (poster)

New papers in 2017: diversity of applications

Hyde, Callow, Rajasekar, Timmins, Patel, Siligardi, Hussain, White, Thomas and **Scott** (2017) Intrinsic disorder in the partitioning protein KorB persists after cooperative complex formation. *Biochem. J.* To be accepted.

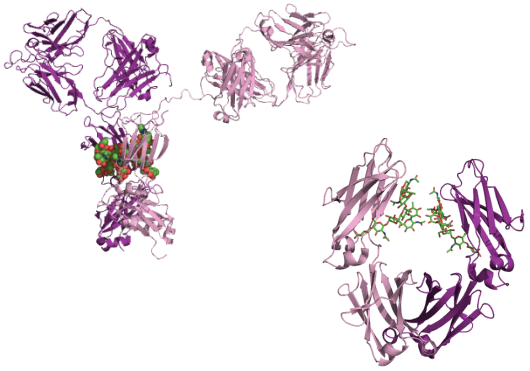


Walker, Nan, Wright, Gor, Bishop, Makhatadze, Brodsky & **Perkins** (2017) Non-linearity of the collagen triple helix in solution and implication for collagen function. *Biochem. J.* In press.



Projects in progress

Antibody IgG glycosylation (Poster)



- **Paul Butler (PI)**
  University of Tennessee Knoxville
  NIST Center for Neutron Research
- Emre Brookes
  University of Texas Health Science Center San Antonio
- Jianhan Chen
  Kansas State University
- Joseph Curtis
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- Tom Irving
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