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The Virtual Observatory paradigm and national projects

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A Virtual Observatory (VO) seeks to provide access to very large volumes of astronomical data over the internet to every interested user, along with software for the data anlysis, and tools for data visualisation, statistics and any other applications which are necessary for mining science from the data. Handling large volumes of data requires extensive computer resources, which may not be available to the end user; transferring data from the data centre to the user needs high bandwidth, which also may not be available. A VO therefore seeks to provide computing resources as well, which could be spread over a grid. The user can locate data of interest through registries, then access the data and analyse it using the computing resources, all through simple user interfaces.

The Virtual Observatory programme, which is now several years old, is being implemented through various national virtual observatory projects, which are federated under the International Virtual Observatory Alliance (IVOA). The IVOA provides a platform for international coordination and collaboration which are necessary to develop standards and tools which can work in a highly interoperable manner. Some of the national projects are large, with a significant number of people working on the development of standards, formats, registries, data models, query languages etc, and also manage immense data bases. Other national projects involve a smaller number of people, who work on the the development of specialised or generic tools compatible with VO standards, which can be accessed either from a specific website, or through other data services.

Some examples of the smaller VO projects, on can mention: (*i*) The Hungarian VO, which has successfully developed VO spectrum and filter services, created the first dynamical synthetic spectrum service, and has released photometric redshifts for more than 100 million objects. (*ii*) The Russian VO provides Russian astronomers effective access to international resources and conversely integrates Russian resources into the international VO structure. (*iii*) The Chinese VO focuses on the development of applications like VOFilter and SkyMouse, and infrastructure deployment through a VO Data Access Service, which will provide VO compliant uniform access interfaces for various astronomical resources. (*iv*) The German Virtual Observatory which serves *ROSAT* data, and has provided cone searches and other tools for the *ROSAT* All Sky Survey. This provides large databases developed through cosmological and hydrodynamical simulations.

Virtual Observatory India (VOI) is the result of a collaboration between the Inter-University centre for Astronomy and Astrophysics in Pune, and Persistence Systems Pvt. Ltd., based in the same city. The VOI is partially supported by a grant from the Ministry of Communications and Information Technology of the Government of India. This unique collaboration between the academia and industry has produced many useful tools for data visualisation, data management, statistical analysis and so forth, often in collaboration with other VO projects in the world.