RVO progress report (Oct 2019)

I. General Catalogue of Variable Stars (GCVS) group (INASAN and SAIMSU, led by Nikolai Samus)

In 2019, it was announced that the Information Bulletin of Variable Stars (IBVS; Konkoly Observatory, Hungary) will be published no longer. By that time, the first part of our 82nd Name-list of Variable Stars was submitted to the IBVS. It contained, besides objects traditional for Name-lists, also variable stars in ten globular clusters of our Galaxy.

In this situation, we are forced to continue our work on Name-lists of variable stars using facilities provided by the electronic journal Peremennye Zvezdy/Variable Stars. Since the IBVS had the advantage of the coverage by SCOPUS, we took effort to ensure that our journal is also covered by SCOPUS. Our effort succeeded, and now the main journal Peremennye Zvezdy/Variable Stars has SCOPUS coverage. However, SCOPUS did not provide coverage to our Supplement Series. The reason for that, formulated by SCOPUS, is that the Supplement Series, unlike the main journal, does not provide pdf files. The technical editor of Peremennye Zvezdy/Variable Stars has now solved the technical problems, and pdf files have been created for all the issues of the Supplement Series published electronically. We are planning to re-apply for SCOPUS coverage of the Supplement Series. The second and third parts of the 82nd Name-list will be published in Peremennye Zvezdy/Variable Stars main journal later this year.

The large amount of research performed by our team in 2016–2019 and covered in the References makes it difficult to reflect every detail in the current brief report. Perhaps the study closest to the general concept of the virtual observatory is that devoted to photographic photometry of Boyajian's star (paper No. 16 in the list of references). This well-known enigmatic object's photometry was performed automatically using scans of plates from the Sonneberg plate collection. The results were compared to those obtained by eye estimates of images from the same scans, performed independently by three experienced observers in Belarus, Estonia, and Russia. They worked at their home computers, accessing the scans remotely. Eye estimates have proven not to be inferior to automatic photometry. Meanwhile, eye estimates were also made on plates of Moscow stacks, not scanned yet.

Reference No. 24 in the list is now considered the standard reference to the version 5.1 of the GCVS. The revision of the GCVS for its version 5.1 has been performed, by now, in 20 constellations.

We continue our work on the GCVS Version 5.1 and are going to add more globular clusters to the list of such objects duly reflected in the GCVS. Leaving them outside the GCVS was mainly related to lacking equatorial coordinates for variable stars in most of them; we solved this problem some time ago.

Our own research of variable stars gave the most interesting results in the field of studying period variations for classical Cepheids and related objects. We are also engaged in photometry of dwarf novae. In our program of scanning the Moscow plate collection, we have published the results for most of the scanned fields. In the field centered at the star 104 Her, we tried, for the first time, to compare the results of traditional classification of variable stars to those obtained automatically, using the random forest algorithm (reference No. 26).

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II. Working group "Astronomical data" (INASAN, led by Dana Kovaleva)

We continue to maintain and develop the Binary Star Database, BDB.Database is available at http://bdb.inasan.ru/ . Recently, we've been working to improve the master catalogue of BDB -- The list of all binary and multiple stars cross-identifiers (Identification List of Binaries, ILB), in respect with proper identification of the components of multiple systems including close binaries. Now ILB includes data on binary systems with pulsating components. Binary systems newly discovered with Gaia DR2 data are being cross-matched with the ILB.

We share information on principles, ideas and results related to the VO with national astronomical community, including via review papers, review reports, and teaching of the students.

Participants: Dluzhnevskaya O.B., Karchevsky A.V., Kaygorodov P., Kovaleva D.A., Malkov O.Yu.

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III. Zvenigorod Scanlaboratory Group (INASAN, led by Sergei Vereshchagin)

The specifics of the astronomical information accumulation are considered. The growth in the amount of information due to digitization photographic images or newly received CCD-images is estimated. Shown, that the speed of information accumulation is higher than the possibilities of its use. The discussed questions can be taken into account for the operation of the Virtual Observatory.

The creation of an image archive of the Zvenigorod Observatory is presented. An online version of the Observation Archive of the Zvenigorod Observatory is available at: http://www.inasan.ru/divisions/zvenigorod/scan/. The INASAN Astrograph ZEISS-400 observations, carried out during the transit of Hyakutake and Hale – Bopp comets, are the most valuable part of the archive. Their images with the scientific description are presented. Observational data are used for scientific research, the results of which are published in reputable scientific journals.

Participants: N.V. Chupina, E.S. Postnikova, M.D. Sizova, S.V. Vereshchagin

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IV. Working group "Technologies of RVO information structures" (IPI RAS, led by Nikolay Skvortsov)

The Institue of Informatics Problems of the Federal Research Center "Computer Science and Control" of the Russian Academy of Sciences (IPI FRC CSC RAS) in cooperation with colleagues from the Institute of Astronomy or the Russian Academy of Sciences (INASAN) continually investigates different aspects and approaches to conceptual modeling of research domains in application to astronomy and astrophysics. Up to 2019 these investigations were related to problems of semantic data exchange in research data infrastructures sharing data and providing data services for communities of researchers in different disciplines including astronomy and its subdomains.

Participants: N.A. Skvortsov, D.O. Bryukhov, A.E. Vovchenko, S.A. Stupnikov

IV.I. Data Interoperability and Reuse

The principles of data interoperability and reuse, known by the acronym FAIR (F – findable, A – accessible, I – interoperable, R - reusable) are analysed. Despite the informality of the FAIR principles declaration, they have implications for research data infrastructure requirements. The problems and requirements related to data semantics for their reuse, and changes in the life cycle of data to ensure their interoperability and reuse have been considered.

FAIR data principles have gathered basic features used in data curation and preservation practices. They are now being propagated in research data infra-structures and open science. These principles are aimed to provide data interoperability and reuse by machines and humans. For this purpose, data should be well identified, semantically defined with shared vocabularies and ontologies, accompanied by provenance information, comply with known protocols, standards, and data models, or have known mappings to them, and have clear access rules.

These principles declare meaningful data exchange and reuse according to machine and human readable shared specifications. It requires formal specifications of research domains accompanying data and allowing automatic reasoning. Development of formal conceptual specifications in research communities can be stimulated by a necessity to reach semantic interoperability of data collections and components, and reuse of data resources. Usage of formal domain specifications reduces data heterogeneity costs. Formal reasoning allows meaningful search and verified reuse of data, methods, and processes in collections.

These means can make research lifecycle in communities more efficient. A lifecycle includes collecting domain knowledge specifications, classifying all data, methods, and processes according to such specifications, reusing relevant data and methods, and collecting and sharing results for reuse.

Existing approaches to data access in astronomy as well as developed approaches in some ongoing international projects are analysed from this point of view.

Global trends for development of massive data collections and related infrastructures in the world aimed at the evaluation of the opportunities for the shared usage of such collections during research, decision making and problem solving in various data intensive domains in Russia. For astronomy, the strategic initiatives in USA and Europe aimed at creation of big data collections and the respective infrastructures planned up to 2025, and IT projects aimed at the development of the infrastructures supporting access to and analysis of such data collections are briefly overviewed. There is a conclusion about an idea of organizing in Russia of a target interdisciplinary program for the development of the pilot project of the distributed infrastructure and platform for the access to various kinds of data in the world, storage of data and their analysis during research in various domains. As a part of such infrastructure, the program should include development of the high performance interdisciplinary center for data intensive applications support.

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IV.II. Developing formal conceptual specifications of research domains for research data infrastructures and particularly for virtual observatories.

A methodology of domain-based conceptual scheme development has been investigated. A semantic approach to the process of development of domain model specifications includes formulating a model of requirements to the domain from verbal descriptions of domain problems, developing a domain ontology, transforming it into a conceptual scheme, and reusing domain knowledge specifications for different purposes in the domain. Relevant data sources are mapped to conceptual schemes of domains in data infrastructures. Requirement specifications are implemented over conceptual schemes for problem-solving. Knowledge of domain object constraints is applied for entity resolution (cross-matching) in data from different domains.

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IV.III. Semantic approaches to problem solving in astronomy and astrophysics

A conceptual approach is proposed to be a promising tool to efficiently deal with multiple sources of semantically heterogeneous astronomical data. It uses problem domain knowledge to formulate the tasks and develop problem-solving algorithms and data analysis methods in terms of domain concepts without reference to particular data sources. It allows solving certain problems in general form. It is demonstrated how the same specifications of astronomical/astrophysical subdomains such as astrometry, photometry, spectroscopy, astronomical
objects, binary and multiple systems, variable stars and others are applied to solve various problems related to search for secondary photometric standard candidates, determination of galaxy redshifts, search for multiple stellar systems, Algol type stars detection and so on. The problems are solve over domain specifications and all accessible data sources semantically related to these specifications.

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The problem of cross-identification of stellar objects contained in sky surveys and catalogs of binaries of different observational types requires matching components and pairs of components of multiple systems by their astrometric and astrophysical parameters. Existing identifiers are verified for belonging to matched components, pairs and systems. The framework of multiple system cross-matching uses domain knowledge of binaries of different observational types to form sets of matching criteria. These criteria are not dependent on source catalogues but take into account knowledge on specific features of objects depending on conditions of observation. The Identification List of Binaries (ILB) has been created after accurate matching of systems, their components and pairs of all observational types. The hierarchical systems of high multiplicity have been analysed on the
base of ILB.

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