JD8

Large Telescopes & Virtual Observatory: Visions for the Future

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https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

Highlights of Astronomy, Vol. 13
International Astronomical Union, 2003
O. Engvold, ed.

Joint Discussion 8: Large Telescopes and Virtual Observatory: Visions for the Future

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Abstract. Very Large scale telescopes and virtual observatories have in common to be global facilities, which will enable entirely new types of sciences and will require new technical and operational philosophies. Joint discussion 8 was built with a series of invited reviews to set the long term vision and challenges, and specific projects or technical topics were presented in the poster session which was also a very important part of the meeting. To keep track of all the contributions, these proceedings contain the abstracts of all papers, invited reviews and accepted contributed posters, with a few extended abstracts.

1. Introduction

Joint Discussion 8, *Large Telescopes and Virtual Observatories: Visions for the future*, was held on July 17 and 18, 2003, in Sydney during General Assembly XXV. The Scientific Organizing Committee was J. Andersen (IAU), J.B. Breckinridge (USA), R.D. Cannon (Australia), O.B. Dluzhnevskaia (Russia), F. Genova (France, Co-Chair), R. Gilmozzi (ESO), R.J. Hanisch (USA), Iye M. (Japan), A. Kembhavi (India), R.P. Norris (Australia), P.J. Quinn (ESO), L.M. Stepp (USA), and Su D.-Q. (China, Co-Chair). A copy of the oral presentations is available on-line at `http://cdsweb.u-strasbg.fr/misc/jd_08.html`.

2. Invited Review Papers

2.1. Large Telescopes

Science drivers for Ground-based Future Giant Telescope (FGT) and Next Generation Space Telescope (NGST)

- **Cosmology, Large-Scale Structure, and Galaxy Formation**
  R. Gilmozzi - European Southern Observatory

  The next generation of future giant telescopes, with projects ranging from 30m to 100m and combining several-fold increases in sensitivity and resolution, will provide a totally new view of the Universe in the optical and near infrared, and will create important synergies with space observatories (e.g. JWST, XEUS) and ALMA.

  I will discuss possible science cases in cosmology, large scale structure and galaxy formation, showing the potentialities of various FGT sizes as well as the scientific requirements that the science cases put on the designs.

  The scientific topics will include the re-ionization epoch, the distribution of dark matter, the emergence of large scale structures, the supernova rate at high redshift, the evolution of the cosmological parameters, the structure and evolution of high redshift galaxies.

- **Formation of Stars and Planetary Systems**
  S. Strom - National Optical Astronomy Observatory, and L.M. Stepp

  We discuss the capabilities of next generation telescopes for addressing key problems in star and planet formation and the characterization of mature planets. Areas to be addressed include: (1) the formation of high mass stars and the origin of the stellar initial mass function; (2) the search for forming planets during the disk accretion phase; (3) new frontiers in exo-planet study. In each case we describe key measurements needed to enable major advances in understanding and the requirements they place on instrumentation and telescope system performance.

Ground-based Future Giant Telescope (FGT)

- **FGT Projects and Their Technological Challenges**
  L.M. Stepp - AURA New Initiative Office

  Around the world more than a dozen optical/infrared telescopes of the 6-10 meter class have been constructed in the past fifteen years. Astronomers and telescope designers are now focusing their attention on the design of even more powerful facilities described as future giant telescopes (FGTs). Many design concepts have been proposed; several of these concepts have received a significant amount of planning and analysis. This paper describes the main FGT projects and discusses the differences among their design concepts.

  Construction of FGTs will be challenging because of their large size and more demanding specifications for image quality, and because the affordability of these telescopes depends on finding ways to build them at costs significantly below the level predicted by conventional cost-scaling relations. This paper describes the key technological challenges faced by each type of design, and shows that many of these challenges are common to all of the concepts.

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- **Progress in adaptive optics and multi-conjugated adaptive optics**
  R. Ragazzoni - INAF, Arcetri and MPIA, Heidelberg

  As single Natural Guide Star Adaptive Optics for 8-10m class telescope turned out recently to become reality and to produce astrophysical result, it is time to review which is the status of the matter, especially in the framework of Extremely Large Telescopes. This will obviously lead to the point of which is the progress status of Multi-Conjugated Adaptive Optics, a technique that, employing more than one Deformable Mirror, promises to achieve diffraction limited capabilities on a much larger Field of View. Today there are several projects in this framework aiming to produce images over a Field of View of about two arc min in size. I note here just three: the MCAO for GEMINI that should employ five laser guide stars that will generate artificial stars to be used as references; the Multi-conjugated Adaptive optics Demonstrator by ESO that will employ two different kind of wavefront sensors, both using three to eight natural reference stars, and NIRVANA, that is a two stage MCAO on the Large Binocular Telescope, used as an interferometer. All of these efforts has clearly an eye on the possible extension of the adopted techniques to Extremely Large Telescopes where, thanks to the larger pupil, some of the conceptual problems are easier to attack. The opinion of the writer is that there is today a wide range of attacks to the problem of achieving AO on ELTs and that in a couple of years, as some of the mentioned technique will be tested on the sky, a more detailed and effective road-map will be traced.

Future Giant Telescope in Space (NGST)

- **The James Webb Space Telescope**
  J.P. Gardner - NASA's Goddard Space Flight Center

  The James Webb Space Telescope (JWST) will be a large (6m) cold (50K) telescope launched to the second Earth-Sun Lagrange point. It is the successor to the Hubble Space Telescope and is a partnership of NASA, ESA and CSA. It's science goals are to detect and identify the first galaxies to form in the universe, to trace their assembly into the Hubble Sequence, and to study stellar and planetary system formation. JWST will have three instruments: The Near InfraRed Camera (NIRCam) and the Near InfraRed multiobject Spectrometer (NIRSpec) will cover the wavelength range 0.6 to 5 microns and the Mid InfraRed Instrument (MIRI) will do both imaging and spectroscopy from 5 to 28 microns.

- **Advanced technologies for future space telescopes and instruments**
  P. Gondoin - European Space Agency

  Astronomical space missions to be launched by the European Space Agency (ESA) include the Planck mission to image the anisotropies of the cosmic background radiation field, the Herschell sub-millimeter space observatory, the Eddington asteroseismology and planet finding mission, the NIRSpec multi-object spectrometer and the Gaia astrometry mission. A brief description of the scientific objectives and model payloads of some of these

missions will be given. These provide guidelines for the technologies to be developed within the next years in the field of astronomical optics for space applications. The Darwin IR space interferometer and the XEUS high energy astrophysics mission currently under study by ESA indicate that future space observatories could consist of telescopes arrays operating in interferometric modes and of very large telescopes assembled into orbit. These future space observatories could make use of innovative technologies such as integrated optics or super-conductive tunnel junctions detectors with intrinsic spectral resolution.

Towards the Global Multi-wavelength Observatory

- **Future giant radio telescopes**
  H. Butcher - ASTRON - No abstract

- **International Collaboration in Astronomy**
  R.T. Schilizzi - Square Kilometre Array Projec)

  A number of the current major ground-based telescopes are international in funding and organisation, but most are not. Astronomical ambitions concerning the next generation of ground-based instruments are so substantial, and the costs so high, that international collaboration and funding may be the only way to realize the goals. I will examine a number of different models for international collaboration from astronomy and elsewhere, and draw some conclusions about their applicability for the next generation of telescopes.

- **Conclusion: IAU and Commission 9 roles in FGT**
  Su D.-Q. - National Astronomical Observatories/NIAOT, Chinese Academy of Sciences

  Looking back, from 1609 Galileo inventing the astronomical telescope to 1993, in 384 years, there were only two astronomical telescopes with aperture larger than 5m: the Russia 6m telescope and U.S.A. 5m Hale telescope. But from 1993 to the present, in only ten years, ten telescopes with aperture more than 8m have operated for astronomical observation. How great progress this is! These telescopes are ground-based telescopes and work in optical and IR waveband. Similar unprecedented achievements have also been obtained in radio telescopes and space missions. All these telescopes and instrumentation enable astronomers to study celestial bodies from the whole electromagnetic spectrum.

  By using various existent telescopes and instrumentation some events in the early universe have been observed. More than one hundred Jupiter-like planets have been found. These stimulate the astronomers and popular people strongly to hope to observe more events in the early universe including the first generation of galaxies to be assembled and to shine in the dark universe i.e. to see the dawn of modern universe, to research star and planet formation, to study black hole, to explore the earth-like planets in nearby stars. Telescopes much larger than existent 8-10m ground-based telescopes and 2.4m HST, and various other telescopes are needed for these

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

researches. The progress in technology creates the possibility to build various much larger telescopes. Here let me only cite ground-based telescope as an example: the success of segmented- mirror Keck telescope created a possibility to build much larger telescopes, and the progress of adaptive optics showed the diffraction-limited image could be obtained at least in IR waveband. By using larger ground-based telescope not only more light energy could be collected, but also the higher resolution can be obtained. Many Future Giant Telescope projects have been put forward and are being developed, such as ground-based 100m OWL, 30m GSMT and CELT, Euro-50; space-based JWST, Herschel, Darwin, TPF, XEUS; radio waveband ALMA, SKA, and many others.

Now every two years SPIE holds astronomical telescopes and instrumentation conferences. This may be the main reason why for many years IAU Commission 9 has had almost no science meeting in these areas. IAU is the most important organization of the international astronomical community. Telescopes, instrumentation, and techniques are an important part of astronomy. New telescope projects are driven by astronomical goals. I think IAU should also hold astronomical telescopes and instrumentation conferences. These conferences should lean toward science goals, and they could make astronomers understand the recent development of telescopes and techniques. These meetings will be complementary with the SPIE meetings. Now IAU leaders show a strong interest in these matters. Dr. Andersen, the former IAU General Secretary, as a representative of IAU attend the SOC of JD8 and Prof. Ekers, the President-Elect of IAU, will give the closing talk for JD8 tomorrow. JD8 is a new beginning. I hope from now on there will be more symposia or colloquia on telescopes and instrumentation sponsored by IAU. And I hope IAU will achieve great successes in promoting the international collaboration on Future Giant Telescopes.

2.2. Virtual Observatories

Rationale, organization and science highlights

- **The Basis for the Virtual Observatory: History and Context**
  E.J. Schreier - Associated Universities, Inc. and STScI

  The International Virtual Observatory has been a concept in the making for several decades. Its realization depended on the convergence of several different technologies. Astronomy has had the advantage of requiring - and thus either driving or adapting - the state of the art in the relevant technologies, and doing so in advance of many other disciplines. As a result, the Virtual Observatory serves as a model for other disciplines. This paper will review the developments - sociological as well as technical - that made the Virtual Observatory first a possibility and then a reality as the technologies matured. It will also discuss the synergism of the VO concept currently being implemented with other forefront developments in astronomy.

- **The International Virtual Observatory Alliance**
  A. Kembhavi - Inter-University Centre for Astronomy and Astrophysics

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

Over the last few years, Astronomical Virtual Observatory (VO) projects have been initiated in several countries. The aim of these projects is to make astronomical data, gathered in all ways and in all places, available to every person who may need it, along with appropriate software for data access, analysis visualization and interpretation. The VO projects largely work in their own ways and with their own priorities, shaped by scientific interests and available resources.

For the VO concept to be successful, these efforts have to be meshed together seamlessly, through inter-operability standards, new data formats which take into account emerging technology, and software developed in forms which are largely independent of platforms and operating systems. It is also necessary to develop computing grids, which will cross national and project boundaries, and can be accessed by any researcher who wishes to use the data mountains. This process of integration and assimilation is to be fostered through international alliances spanning various VO efforts. I will describe in my talk formal alliances, like the International Virtual Observatory, as well as specific bilateral and multilateral collaborations between individuals, institutions or projects, and the VO related products that have been launched through these collaborations.

- **Science highlights: Star clusters and ASTROVIRTEL**
P. Anders - Universitäts-Sternwarte Göttingen, and R. de Grijs - Extended abstract

We introduce the potential of star cluster astronomy as a robust tracer of galaxy formation and evolution, and discuss the importance and relevance of linked multi-passband data archives (e.g., through the Virtual Observatory initiative) for its success. As an example, we present first results of a study utilizing the tools provided by the ASTROVIRTEL project built as a direct outcome of our approved proposal 'The Evolution and Environmental Dependence of Star Cluster Luminosity Functions', and incorporated in the QUERATOR data mining facility.

As a result of the wealth of available observational data in the Hubble Space Telescope and ESO archives, the mining and retrieval of which were facilitated by the ASTROVIRTEL project, considerable feedback onto our stellar population models resulted in an iterative learning process: our models needed to be extended to cover the full parameter space spanned by our observed cluster parameters, and efficient tools to compare the observations with our model grid were developed. Both are finished, and the scientific phase of the project, i.e., the analysis of the large data volume, has started. Essentially, our data analysis tools allow us to determine the basic physical parameters (age, metallicity, extinction, mass) of each individual cluster in a given galaxy. From this we derive the required information about when and under which conditions the star clusters were formed.

From the outset, this approach applied to our first example object, the dwarf starburst galaxy NGC 1569, resulted in a number of surprises. While the burst of star cluster formation in this galaxy appears to be shorter than

the burst of general star formation in the field (as derived from the resolved stellar population), the average masses of the star clusters decrease as the burst of star cluster formation proceeds. This burst temporally coincides with the close passage of an intergalactic HI cloud. This suggests, therefore, that star cluster formation occurs predominantly during violent episodes of star formation. The change in the star cluster mass function is most likely related to the changing conditions of the interstellar matter from which the clusters were built.

`http://archive.eso.org/querator/`

- **Science highlights: Automated Classification of X-Ray Sources**
  R.J. Hanisch - Space Telescope Science Institute, and A.A. Suchkov, R.L. White, T.A. McGlynn, E.L. Winter, M.F. Corcoran, W. Voges

  ClassX is a Virtual Observatory prototype project aimed at the semi-automated classification of unidentified X-ray sources. ClassX draws from numerous on-line object catalogs using VO standard protocols to collect multi-wavelength position, flux, and source extent information. These data are used to train oblique decision tree classifiers. With ClassX we find large candidate populations of massive stars and T-Tauri stars, more than five times more numerous than the respective populations identified in the ROSAT WGACAT catalog. Many O-F5 and K-M candidates are found along sight lines to the LMC and SMC. A number of O-F5 and K-M candidates are bright IR sources with J-K excesses of 2 magnitudes and more, suggesting thermally emitting, hot circumstellar dust disks indicative of a pre-main sequence population. ClassX finds about twice as many new X-ray binary star candidates than in WGACAT, concentrated in the direction of the LMC and SMC. Many of these likely XRBs have harder X-ray spectra, suggesting a new class of previously unknown, extreme types of these objects. We also see that among extra-galactic objects, quasars are the most likely candidates for previously unidentified WGACAT sources, exceeding the population of galaxies and AGNs by factors of two to three.

- **The VO and Ground-Based Data**
  J. Huchra - Harvard-Smithsonian Center for Astrophysics

  The era of extremely large, public databases in astronomy is upon us. Such databases are opening the field to new research and new researchers. However it is important to be sure the resources are available to properly archive ground-based astronomical data, and include the necessary quality checks and calibrations.

  A Virtual Observatory without proper archives will have limited usefulness. This also implies that with limited resources, not all data can or should be archived. NASA already has a very good handle on US space-based astronomical data. Agencies and organizations that operate astronomical facilities, particularly ground based observatories, need to plan and budget for these activities now.

  We should not underestimate the effort required to produce high quality data products that will be useful for the broader community. Currently the

best way to "fill" archives is with data from surveys. That will continue to be the case for most ground based observatories.

- **The Theoretical Virtual Observatory**
  S. White - Max Planck Institute for Astrophysics

  A functioning virtual observatory will require easy and transparent access not only to diverse observational databases, but also to the tools needed to analyze, visualize and interpret them. For the large statistical datasets produced by modern, multi-wavelength surveys, this almost always requires the use of equally large, artificially generated "mock" surveys. These are used to calibrate observational biases introduced, for example, by flux or resolution limits, and to study how differing physical effects are manifest in the observational plane (for example how the observable clustering of galaxies is affected by merging, by collision-induced starbursts, by harassment, etc). Such mock catalogues are almost always produced from large-scale supercomputer simulations, so the "virtual observer" of the future will need access to such theoretical datasets or to the computer codes and resources needed to create them. At the MPA and within the Virgo Super-computing Consortium we have for several years publically released both supercomputer code and large, simulated datasets. I will review how this experience can help in the design of the theoretical component of a virtual observatory.

- **Science highlights: Discovery of Brown Dwarfs with Virtual Observatories**
  J.D. Kirkpatrick, presented by G.B. Berriman - Infrared Processing and Analysis Center, R.J. Hanisch, A. Szalay, R. Williams

  We describe how to use cross-matching between the 2MASS and SDSS source catalogs to find brown dwarf candidates that are cooler and more distant than those discovered to date in the individual surveys. Our eventual goal is use the cross-matching to discover brown dwarf candidates from the large numbers of usually spurious single-band detections in each survey. A pilot study conducted for the NVO illustrates the power and promise of the method. This study searched for brown dwarf candidates that were detected only in the z-band in SDSS and in the J band in 2MASS. In our first trial we cross-matched all 2MASS Second Incremental Data Release (IDR2) sources falling within 3 arc sec of an SDSS Early Data Release (EDR) source. The cross-match covered an area of roughly 150 square degrees and contains 326020 matches. Further filtering through a conservative z-J color cut recovered the known brown dwarfs in that area - a T dwarf (SDSS 1346-0031) and a late-L dwarf (SDSS 1326-0038) while also uncovering three more excellent brown dwarf candidates. One of these (2MASSI J0104075-005328) has been spectroscopically identified as an L5 dwarf.

- **Science Highlights: Science from the AVO 1ST Light: the High Redshift Universe**
  N.A. Walton - Institute of Astronomy, University of Cambridge, and M.G. Allen

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

The Astrophysical Virtual Observatory science working group defined a number of key science drivers for which the AVO should develop capabilities. At the AVO's Jan 2003 'First Light' event, the AVO prototype data access and manipulation tool was demonstrated. In particular its use in enabling discovery in deep multi wavelength data sets was highlighted. In this presentation I will describe how the AVO demonstrator has enabled investigation into the high redshift universe, and in particular its use in discovering rare populations of high redshift galaxies from deep Hubble and ground based imaging data obtained through the Great Observatories Origins Deep Survey (GOODS) programme.

Round table Discussion

The round table discussion was chaired by O. Malkov and Ohishi M.. Ohishi M. introduced the discussion, and then several papers were presented, dealing with different aspects of the VO. Two talks presented emerging VO projects in Australia (D. Barnes, abstract in the Poster section) and in South Africa (P. Woudt). T. Dorokhova discussed the important topic of Thesaurus is astronomy (paper presented by F. Genova, abstract in the Poster section). Tatematsu K. presented a user point of view on the "VO for diverse interests". G.T. Rixon discussed the GRID paradigm.

Conclusions

- **How Will the VO Affect Astronomy?**
  G. Gilmore - Institute of Astronomy, University of Cambridge

  The Virtual Observatory is in that optimistic yet dangerous phase of development where everyone believes it will solve all problems, but not really force any involuntary changes on the way astronomy is done. The same statements were made about the Internet a few years ago.. Progress in astronomy has depended on individual insight, and has also typically been led by small groups with the best technology and greatest resources. More commonly today, multi-partner collaborations with at least significant public funding develop the largest projects, with rapid public data access an obligation. The one goal of the astrophysical virtual observatory is to provide the analysis tools and practical access to those data to a very wide community. When this is achieved, as it will be, given the excellence and enthusiasm of those involved, astronomy will be one step towards solving its people-problem: the whole community will be able to think about the best data. This threatens PIs, imposes huge strains on funding, makes it harder for groups to do well by resource control, will potentially restructure the present link between excellence and place of research, and will force all of us to try harder. Excellent.

- **Summary: Commission 5 role in the VO**
  F. Genova - Centre de Données astronomiques de Strasbourg

  Astronomy is a small discipline, with few commercial constraints and a long tradition of data conservation and of partnership to define standards, with FITS as a figurehead. Information networking is already an everyday

tool for astronomers, which can for instance access bibliographic information from ADS, SIMBAD, NED, from the electronic journals, from the VizieR catalogue and table database, and from observatory archives, and can also surf easily from one information service to the other. The next step is now to integrate information, including large surveys, theory, ... The Virtual Observatory is *an enabling and coordinating entity to foster the development of tools, protocols, and collaborations necessary to realize the full scientific potential of astronomical databases in the coming decade* (NVO White Paper, June 2000). It is science driven, not technology driven (although it aims at making the best usage of Information Technologies for building tools for astronomers). VO projects arose from active and experienced groups, which cooperated at the international level from the very beginning. The Virtual Observatory is one of the very few truly global endeavors of astronomy. Each project pursues its own goals (as accepted by its financing agencies), with a common goal, giving transparent access to data and tools for users from all around the world - which should bridge gaps in data and information access and accessibility. They all work together to define inter-operability standards. New teams (even small teams) from other countries are welcome to participate, publish their data, create new tools to be used in the general frame, join the IVOA inter-operability working groups, etc

IAU Commission 5 (Documentation and Astronomical Data) has been eager to take into account the rapid evolution of data dissemination since the advent of the Internet, by implementing a dedicated Working Group, first called *Data Centres and Networks*, which became *Data Centres, Networks and Virtual Observatories* in 2000, and will be *Virtual Observatory* from the General Assembly on.

2.3. Closing talk: Big telescopes, big data, more science (R.D. Ekers - UAI, ATNF)

R. Ekers, IAU President, agreed to present Joint Discussion 8 concluding remarks. He explained that the IAU executive combined the requests for a meeting on large telescopes with a request from the Virtual Observatory community into this single Joint Discussion. He commented on the differences in approach between these two groups, but also the need for both to work closely together, and on his hope that IAU can facilitate this interaction.

He illustrated the following points from his experience in radio-astronomy: both hardware and software developments are needed to exploit the potential of new facilities; one needs to include projection of new capabilities when designing instruments; different approaches are used in the management of hardware and software projects in astronomy, which in part lead to the very different issues and approaches which have been discussed in the two halves of the JD8 meeting. He listed important topics pleading for diminishing the separation between the IVO and the telescope building communities: learning from each other; the need for the IVO to understand the impact of new hardware technologies, and for technology developers to understand the IVO since this new paradigm might effect optimum hardware design. This is a difficult challenge because of the need to extrapolate expected performances into the future to build the optimum

strategy. Difference in times scales also have to be taken into account with complex software taking longer to develop than the time scales for computer hardware developments.

IVO developments can play a key role in the broader applications of shared databases. Fortunately for astronomers the stars and galaxies have no privacy requirements and so we can develop tools to link and explore multi-wavelength databases in a much easier environment than for example in epidemiological studies where databases have to be linked through peoples names. Developments in IVO can be used to help solve the far more difficult epidemiology problems.

R. Ekers reminded us that the IAU mission is to promote the science of astronomy worldwide. The IVO is a visionary project which has to be international to succeed and has a natural and supportive home in the IAU.

3. Poster papers

3.1. Large Telescopes

Future Giant Large Telescopes and Sites

- **Status of the Southern African Large Telescope (SALT)**
  D.A. Buckley - Southern African Large Telescope

  SALT is well over half way to completion. By the end of 2003, all major subsystems, including the commissioning instrument, will be in place and the commissioning of them begun. Tests of a subset of the mirror array, including the Shack-Hartmann alignment instrument, the mirror actuators, capacitive edge sensors and active control system will also have started. Finally, the first on-sky tests involving the complete light path, from object to detector, will be completed.

  This paper describes the status of the SALT project, due for completion by the end of 2004, including the major science drivers and first-generation instruments. These are confined to the visible spectrum, but optimized for UV performance, with capability from $\tilde{3}$20-900 nm. Instruments will have access to an 8 arcmin diameter science field and will be seeing limited. The telescope design necessitates queue-scheduled observing, ideal for survey science and time resolved studies of astrophysical phenomena, an important aspect of the overall SALT science drivers. Special efforts are being made to ensure such a capability by employing frame transfer CCDs. Initial instrument capabilities include broad and narrow band imaging, long-slit and multi-object spectroscopy, polarimetry, Fabry-Perot imaging spectroscopy and high resolution fibre-fed spectroscopy.

- **Two Chinese Telescope Projects Based on Active Optics**
  Su D.-Q. - National Astronomical Observatories/NIAOT, Chinese Academy of Sciences, and Nan R.

  Two special telescopes are being developed in China, which cannot be realized in traditional ways. One is the Large Sky Area Multi-object Fiber Spectroscopic Telescope (LAMOST). It has a 4m aperture and 5 degree FOV, with a reflecting Schmidt optical system. Three main parts: the

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

reflecting correcting plate, the focal surface and the spherical mirror lie on the ground along north to south. During observation only the alt-azimuth mounting of reflecting plate and the focal surface do the tracking rotations. In this situation the shape of correcting plate should be changed with the change of sky area. LAMOST has been approved by Chinese Government. Another is the radio telescope FAST, Five Hundred Meter Aperture Spherical Telescope. It will be sited in a Karst hole like Arecibo 305m telescope. The main difference between FAST and Arecibo is: during the observation the illuminated area (300m diameter) of FAST will be changed from spherical surface into a paraboloid. Thus spherical aberration correcting system is unnecessary and a simple feed can be put in its focus. It reduces very much the weight and complexity on the cable. The feasibility study has been financed by the Chinese Academy of Sciences and completed successfully in 2002.

- **A Configuration for Chinese Future Giant Telescope (CFGT)**
  Cui X. - National Astronomical Observatories/NIAOT, Chinese Academy of Sciences, and Su D.-Q., Wang, Y.-N.

  In this paper a preliminary configuration for Chinese Future Giant Telescope (CFGT) is proposed. It is a 30m telescope using segmented primary mirror alt-azimuth mounting. The primary mirror is aspherical f-ratio 1.2 and it consists of 1095 submirrors. This telescope includes Nasmyth coude and a wide field of view optical systems. There are some characteristics in CFGT: (1) Partial annular submirrors are used;(2) One of coude planar mirrors is aspherical and the better image quality is obtained for such a coude system. (3) A pair of lens-prism is used in wide field of view system. The better image quality is obtained and atmospheric dispersion is corrected.

  We believe China has gained adequate potential to build a 30m telescope even if China has not build 8-10m telescope, because:(1) The economics has been developing very fast in recent 25 years; (2) We are obtaining experiences and technologies from national project LAMOST;(3) A glass factory in Shanghai has got experience to manufacture the zero thermal expansion mirror blank VO2 for about 25 years; (4) We have specially bought an annular polishing machine for the large number of submirrors' polishing; (5) Site exploration on Qinghai-Tibet Plateau for future giant optical/infrared telescope has started.

- **Canadian Efforts Towards a Future Large Telescope**
  D. Crabtree - National Research Council Canada, and S. Roberts, R. Carlberg, D. Halliday

  A Very Large Optical Telescope (VLOT) was identified as a high priority project in the Canadian Long Range Plan for Astronomy that was published in early 2000. The VLOT concept is for a 20-m segmented mirror telescope that could replace the CFHT on Mauna Kea. Technical studies and some design work have been undertaken by both NRC-HIA and AMEC Dyanamic Structures over the past two years. VLOT effort is now funded at the $1M (Cdn) per year level. This presentation will describe the Canadian work to date.

- **Next Generation CFHT: Concepts and Optical Performance**
F. Zamkotsian - Laboratoire d'Astrophysique de Marseille, and K. Dohlen, D. Burgarella, M. Ferrari

  The Canada-France-Hawaii Telescope (CFHT) community is engaged in studies for the replacement of the present 3.6m telescope, until recently considered one of the best telescopes in the world, by a world-class research facility at the beginning of next decade. The motivation to design and build a new telescope is driven by the astronomers need to observe fainter sources. The basis of the next generation CFHT (NG-CFHT) is therefore to increase the size of the primary mirror up to 20-30m. Beyond this photon quest, the way we use the photons is also very important.

  We propose to develop a NG-CFHT which is able to handle and take advantage of parallel observing with several instruments simultaneously. New technologies e.g. active and adaptive wavefront control Micro Opto Electro Mechanical Systems (MOEMS) will permit an optimization of the telescope performance. We present different optical concepts based on a segmented primary with 8 large 8m-class aspheric petals. Optical performance is evaluated through PSF calculation for the different concepts.

- **The Case for Small Telescopes in the Age of Giants**
T.D. Oswalt - Florida Institute of Technology

  The closures of 1-4m telescopes at several international facilities over the past decade have been cause for lament in the astronomical community. However, the future of small telescopes in the dawning era of giants should be quite bright if creative steps are taken. This paper will address some of the scientific and productivity issues that argue persuasively that a strong partnership between small efficient telescopes and the new generation of giant telescopes is essential. For example, among a host of functions that can best be performed by small telescopes are the development of innovative approaches to operations instrumentation, and unique research projects. To accomplish these, it will be essential to improve the operational efficiency of existing small facilities via more frequent use of standard off-the-shelf technology, optimization of individual telescopes for special projects, increased use of active and adaptive optics, automation, and remote access. A selection of scientific initiatives will be presented that are ideally suited for new (or renovated) small telescopes.

- **Magdalena Ridge Observatory Project Overview**
B.E. Laubscher - Los Alamos National Laboratory, and D. Buscher, M.J. Chang, M.L. Cobb, C.A. Haniff, R.F. Horton, A.M. Jorgensen, D. Klinglesmith, G. Loos, R.J. Nemzek, S. Restaino, V. Romero, E. Ryan, W. Ryan, S. Teare, L. Trusdell, D. Voelz, D. Westfahl

  The Magdalena Ridge Observatory (MRO) is a project with the goal of building a state of the art observatory on Magdalena Ridge, west of Socorro, New Mexico. This observatory will be sited above 3700 meters and will consist of a 10-element, 400-meter baseline optical/infrared imaging interferometer and a separate, 2.4-meter telescope with fast response capability. The MRO consortium members include New Mexico Institute of

Mining and Technology, University of Puerto Rico, Mew Mexico Highlands University, New Mexico State University and the Los Alamos National Laboratory. The University of Cambridge is a joint participant in the current design phase of the interferometer and expects to join the consortium. We will present an overview of the optical interferometer and single telescope designs and review their instrumentation and science programs.

- **Mt. Maidanak and Plateau Suffa as a Candidate Sites for FGT**
  S. Egamberdiev - Ulugh Beg Astronomical Institute of the Uzbek Academy of Sciences, and S. Ilyasov

  The astroclimate studies at Mt. Maidanak, located at a distance of about 120 km south of Samarkand, Uzbekistan, carried out in co-operation with ESO, Universities of Nice and Moscow in 1996-2002 indicated that it is one of the most favorable sites world-wide for astronomical observations. Not only this fact but also an exceptional geographical location, very complementary to the main international facilities of Chile, Canaries and Hawaii, makes Mt.Maidanak very attractive for observational programs requiring continuous monitoring of astronomical objects. Recent results of site testing at Mt. Maidanak as well as summary of results obtained in frame of collaborative programs with advanced western institutions will be presented. In the 80s the Suffa plateau located at a distance of about 200 km south-west of Tashkent was selected for construction of observatory with 70m radiotelescope (RT-70) for submm range as a main instrument. Just before the end of the SU, about 60% of facilities including 105 m high pillar of the RT-70 were constructed. Now an Uzbek-Russian intergovernment Agreement on constructing the radio observatory has been signed and at present both governments show increasing interest on finalizing this project.

- **Mt. Dushak-Erekdag Observatory as a potential site for the Future International Observatory**
  T.N. Dorokhova - Astronomical Observatory of Odessa National University, and N.I. Dorokhov

  The Mt. Dushak-Erekdag Observatory (Central Asia, Turkmenistan, the longitude 58° E, the latitude +38°) is located just in the "longitudes' gap" of asteroseismological networks. Our observations during many years have shown that the sky seeing at the site is one of the best in Central Asia: a low light pollution, high and stable sky transparency, over 200 usable nights per year. The altitude is above 2000 m. Characteristics of the locality have such fortunate combination of the features which makes this site unique for building of FGTs. We present the project of the Future International Observatory at the Mt. Dushak-Erekdag.

New Techniques and Methods

- **LAMA - a Novel Concept for a Very-Large Optical Telescope**
  P. Hickson - University of British Columbia, and K.M. Lanzetta, A. Crotts, M. Shara, B. Truax, B., J.K. Webb

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

We report preliminary results of a conceptual design study for a next-generation ground-based telescope. The Large-Aperture Mirror Array (LAMA) would be a multi-aperture telescope employing rotating liquid-metal primary mirrors. Tracking systems, comprised of articulating aspheric mirrors traversing the focus of each primary mirror, would allow this telescope to point and track within an 8-degree diameter region. Light from all primary mirrors would be combined at a common focus. Adaptive optics, in conjunction with phase-tracking and a Fizeau beam combiner, would allow the telescope to achieve milli-arcsecond resolution in fields surrounding natural guide stars. With an effective area equivalent to that of a 50-meter telescope, LAMA could reach sub-nanoJansky flux levels in targeted areas. Equipped with a multi-band optical-infrared camera and a high-resolution spectrograph, it would be a powerful tool for exploring the distant and local universe, stellar systems and extra-solar planets.

- **Status of Active Optics Methods and Applications to FGTs**
  G. Lemaitre - Laboratoire d'Astrophysique de Marseille, and M. Ferrari, K. Døhlen, F. Zamkotsian

  A short review of today state of the art in active optics techniques will be presented. The two mains topics addressed by these techniques will be considered and detailed. Active optics processes applied during optical manufacturing have many advantages for the realization of aspherics or extreme optics (stress polishing techniques). Examples of realization will be given. The high potential of active techniques for in-situ control of large mirrors shape has been fully demonstrated with the results obtained with the VLT project. Another example of this clever solution for mirror shape control is the original LAMOST project. Considering the technological challenges raised by the future generation of giant telescopes FGTs ranging from 20 to 100m, the active optics techniques can be a solution to many of the foreseen difficulties. The advantages of active optics will be emphasized in the perspective of the realization of FGTs and improvement of their performances.

- **Active Optics Concept for Hyper Telescopes**
  K. Dohlen - Laboratoire d'Astrophysique de Marseille, and P. Dargent, M. Ferrari, G. Lemaitre

  The Hyper Telescope (HT) based on densified sparse pupils is one of the instrumental concepts under study for future large-baseline interferometers. Its compatibility with stellar coronography makes it interesting for exo-planet search and characterization. Baselines considered for first-generation HTs are of the order of 100 m but one can envisage kilometric arrays capable of unprecedented angular resolution. The focal plane instrumentation, including aberration correction and pupil densification optics, is included in an instrument space craft (ISC) located in the primary focus.

  In this paper we present optical and mechanical concepts for combined aberration correction and pupil densification using multi-mode deformable mirror (MDM) and mechanically amplified piezo actuator technologies. Among the advantages of such a system over large monolithic corrector

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

optics is the relaxation of piston alignment requirements between primary segments.

- **MOEMS, Micro-Optics for Future Astronomical Instrumentation**
  F. Zamkotsian - Laboratoire d'Astrophysique de Marseille, and P. Lanzoni, A. Liotard, K. Dohlen

  Scientific breakthroughs often follow technological breakthroughs permitting to make significant steps forward. Astronomical research of the next decade is related to the quest for our Origins: How did Galaxies form? How did Stars and Planetary Systems form? Can we detect Life in other Planets? The science requirements provided by those topics are very constraining for future astronomical instrumentation calling for multiplexing capabilities and high spatial and spectral resolutions.

  In Laboratoire d'Astrophysique de Marseille we have been engaged for several years in developing micro-optical components for the so called Micro-Opto-Electro-Mechanical Systems (MOEMS). The major advantages of these components are their compactness, scalability, and specific task customization using elementary building blocks. We are studying programmable slit masks for Multi-Object Spectroscopy (MOS) and micro-deformable mirrors for next generation Adaptive Optics (AO) systems.

  We will present our work on modeling and characterization of the micro-mirror array (MMA) for generating reflective slits and the micro-shutter array (MSA) for generating transmissive slits for MOS application. We will also discuss our recent developments of micro-deformable mirrors in our collaboration with micro-opto-electronics laboratories. We are involved in JWST VLT2 NG-CFHT and OWL studies.

- **Mach-Zehnder Phasing Sensor for ELTs**
  K. Dohlen - Laboratoire d'Astrophysique de Marseille, and L. Montoya-Martinez

  Segmented mirror technology has been successfully applied to 10m class telescopes (Keck, HET, GTC) and its application to future extremely large telescopes (20m NG-CFHT, 30m CELT, 50m EURO50, 100m OWL) is required. Extensive use of adaptive optics in these telescopes puts stringent specifications on wavefront error allowing typically of the order of lambda/20 to segmentation errors. Several phasing metrology schemes adaptable to these giant telescopes are under development.

  We investigate a novel technique based on the Mach-Zehnder interferometer with a spatial filter in one arm. Atmospheric turbulence is tolerated in this setup if the spatial filter has the size similar to that of the seeing disk. The resulting interference pattern only contains the high-frequency spatial information including information about the piston step height.

  We describe the theoretical analysis of this system and show simulated and experimental results. Different error sources are analyzed in order to provide a preliminary idea of the merits of this technique compared with other phasing techniques.

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

- **New Method for Stellar CCD Photometry**
A. El-Bassuny Alawy - National Research Institute of Astronomy and Geophysics

The ALAWY stellar CCD photometry method (Alawy 2001 Ap&SS 277 473) is outlined. Further development has been done to handle the case of uneven background brightness employing simple numerical technique. Several CCD frames of different specifications have been adopted to test the method. The result obtained is excellent in view of the accordance between magnitudes derived and the published ones.

- **Simulating Interferograms for Testing Big Dimensions Optics**
A. Rodriguez-Hernandez - INAOE, and J. Castro-Ramos

Based on two interferometric modern techniques, Electronic Speckle Pattern Interferometry and Fringe Projection Technique, we have realized simulations of interferograms for both rough aspherics surfaces around five microns and five meters in diameter up. Experimental interferometric setup is proposed and developed software with which we reached our goal is explained.

- **The Limit Magnitude for the Next Extremely Large Telescopes**
Z. Benkhaldoun - LPHEA Cadi Ayyad University, and T. El Halkouj, R.G. Petrov, M. Lazrek, Y. El Azhari

This work consists in determining the limit magnitude of co-phasing for an interferometer made of N telescopes simultaneously co-phased on a natural star, then to compare it with that for a mono-pupil of the same collecting surface. We showed that the simultaneous co-phasing telescopes made an interferometer less powerful than if its surface is divided into a greater number of pupils. The configuration of co-phasing in which the groups of pupil are organized in hierarchical structure are studied to decrease this disadvantage. The limit magnitudes are founded on an estimate of the signal to noise ratio (SNR) of (or for) sensor of fringes taking into account the noise of photons, thermal noise and detector noise reading, for conditions of seeing given, supposing all bases are larger than external scale of optical turbulence.

- **2-CLEAN DSA Method for Simulation and New Systems Projecting**
M. Agafonov - Radiophysical Research Institute, NIRFI

In [1,2,and 3] we have presented the 2-CLEAN DSA Method for tomographic and astronomical image reconstruction. This technology can help simulate and create new systems. The basic principles in modern tomography and in astronomy are the necessity to take into account the physical character of the problem and the demand to start the instrument projecting after the algorithm has been created and examined. The latter, unfortunately, was not used in medicine earlier and because of great number of projections the radiation dose was sufficient. Radioastronomy has made a considerable contribution to the solution of some important problems that are the same for radioastronomy and tomography [4], which, as

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

it seems to us, it can be proud of. We present the technology of simulation for creating of tomographical or astronomical systems by few projections of knife beams, for optical slits systems with having the opportunity to investigate in a wide space frequency range. 1. Agafonov M.I. ASP Conf. Ser. v.125 ADASS VI p.202, 2. ASP Conf. Ser. v.145 ADASS VII p.58 3. Agafonov M.I. Few Projections Astrotomography: 2-CLEAN DSA Reconstruction, 4. IAU00446 & Radioastronomical approach to Few Projections Tomography. IAU00450. See also abstracts IAU GA 2003, JD09.

- **New Solutions, Innovative Materials for Giant Telescopes**
  G. Marchiori - European Industrial Engineering, and F. Rampini, L. Ghedin, S. de Lorenzi, A. Zanon, L. Giagomel

  The VLT 8-m ground-base telescopes, successfully realized and commissioned, are now producing science.

  The European Prototype for ALMA project is manufactured and now under erection.

  Based on these experiences, EIE will present his status of the new solutions for mirror cell structures and for telescope buildings.

- **The Impact of Radio Interference on Future Radio Telescopes**
  D.A. Mitchell - The University of Sydney, School of Physics, and G.J. Robertson, R.J. Sault

  While future radio telescopes will require technological advances from the communications industry, interference from sources such as satellites and mobile phones is a serious concern. In addition to the fact that the level of interference is growing constantly, the increased capabilities of next generation instruments make them more prone to harmful interference. These facilities must have mechanisms to allow operation in a crowded spectrum. In this report some of the factors which may limit the effectiveness of these mechanisms are investigated. Radio astronomy is unique among other observing wavelengths in that the radiation can be fully sampled at a rate which completely specifies the electromagnetic environment. Knowledge of phases and antennae gain factors affords one the opportunity to attempt to mitigate interference from the astronomical data. At present several interference mitigation techniques have been demonstrated to be extremely effective. However the observational scales of the new facilities will push the techniques to their limits. Processes such as signal decorrelation, varying antenna gain and instabilities in the primary beam will have a serious effect on some of the algorithms. In addition the sheer volume of data produced will render some techniques computationally and financially impossible.

- **Feed Designs for the Lovell and MKII/Defford Telescopes**
  Su Y. - National Astronomical Observatories, Chinese Academy of Sciences

  In order to remain competitive with, eMERLIN requires the development of four new feed designs to cover the 4 to 8 GHz band, for the Lovell Telescope, MkII and Defford, Cambridge, and the E-Systems Telescopes. The need, in each case, for good return loss and constant beam width

across an octave band presents a set of difficult challenges. The prototype Lovell and MKII/Defford feeds have been designed, manufactured and tested, both in the laboratory and on the telescopes.

- **Multi-Band Film Lens Antennas for Radio Telescope Satellites**
  Ujihara H. - National Astronomical Observatory in Japan, and Chikada Y., Nakahira K.T.

  Large reflector antenna is a conventional way to achieve high sensitivity of radio telescopes, but keeping accurate reflector surface becomes more difficult in higher frequency or larger antenna aperture. Radio telescopes with lens antenna would be less sensitive to surface errors and pointing accuracy than with reflector antennas, however, no practical studies have ever been done about large lens antennas. We developed Film Lens Antenna (FLA), which has very low insertion loss and mass. This is fundamentally Fresnel lens antennas with unique phase shifter films which were newly developed and which cause FLA to have a simple plane structure with a few films. Therefore it is especially useful for a main antenna of a satellite like "HALCA" which is a radio astronomical satellite for the first Space-VLBI mission.

  We can design transparent phase shifter films with arbitrary phase shifts to $\pm$ 180 degrees to make efficient lens. We made 90-cm FLAs for 22GHz based on our previous numerical works and measured its efficiency as 40%. This is a satisfactory result as a first step of FLA to gigantic aperture radio telescopes. Also we designed and measured multi-band films toward more practical FLA which can simultaneously receive 86GHz, 43GHz, 22GHz for example.

- **Spherical Dish Huge Array from Radio to IR**
  Sawano A. - Waseda University, Institute for astrophysics, and Okubo R., Takefuzi K., Yoshimura N., Ichikawa H., Matsumura N., Kuniyoshi M., Takeuchi H., Asuma K., Daishido T.

  Eight element 20m spherical dish array was constructed as a digital interferometer for searching radio transient sources and pulsars. Wavelength ratio to IR is 10000. We investigate the possibility in extending wavelength to IR. In spherical dish all segment mirrors have identical iso-curvature, which makes it possible to use mass-produced system. In our spherical dish array, 36x2x8 = 576 segment mirrors are used. Present surface accuracy of 2mm rms must be reduced to 0.01 mm in IR, which requires smaller segment mirrors. Aberration correcting asymmetrical Gregorian sub-reflector is used in the present radio observation watching to five degrees from zenith and focus is at bottom in each dish. Thus the sky from +32 deg to +42 deg zone in declinations is observable. Only Az rotation of sub-reflector and feed horn are required. Four box PCs reading sixteen Az rotary encoder outputs of the sub-reflectors and the feed horns control them to rotate. Main PC watching all system is connected with the box PCs by RS485 cables. Total construction cost of the present eight element array in radio waves was $1.2M. Present digital phase correction system might be useful in future digital adaptive optics system in IR Spherical Dish Huge Array.

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

3.2. Virtual Observatories

Status reports of Virtual Observatory projects

- **The Australian Virtual Observatory Project: 2003 and Beyond**
  D.G. Barnes, The University of Melbourne

  The Australian Virtual Observatory is funded in 2003 to bring a number of premiere Australian astronomy archives on-line and to begin prototyping virtual observatory tools and processing pipelines relevant to Australian astronomers. We are exploring the use of a commercial database to publish source catalogs such as HIPASS and SUMSS, both with VOTable export capabilities. Meanwhile, the catalog of quasars from the 2dF galaxy redshift survey will be published using the Canadian Virtual Observatory resources, and the CSIRO is hosting a cross-divisional project to place the entire archive of observations with the AT Compact Array on-line with a sophisticated search interface honoring data providence and proprietary periods. In terms of virtual observatory tools, a joint project is underway with AstroGrid to grid-enable an existing high-performance volume rendering application, making it available to users without requiring special hardware or software, and the ATNF is building on its expertise in visualization to develop a Java-based interface to existing AIPS++ display tools.

- **Science and the Virtual Observatory**
  D. Schade - National Research Council Canada, and P. Dowler

  The Canadian Virtual Observatory (CVO) is the cornerstone of a budding international partnership that delivers high quality scientific content and capabilities to the astronomical community. We have developed a uniform astronomical data model to characterize all types of observational data across the entire electromagnetic spectrum; this model enables users to find archive data based on the content and the quality without letting the technology get in the way. We have also developed general purpose source and object catalogs to store information extracted from the data using standard techniques and algorithms. These catalogs are explorable with a variety of scientific tools, from a web interface for simple tasks to a programmatic interface for sophisticated analysis involving client and server side processing. Finally, all of the data processing and analysis tasks we have executed or will execute are viewable via our processing catalog; links between object and source catalogs, processing catalogs, and observation catalogs allow users to examine the complete pedigree of every single derived value. Thus, the entire system is open to peer review which is the cornerstone of science.

- **Grid Based Chinese Virtual Observatory System Design**
  Cui C. - National Astronomical Observatory of China, and Zhao Y.

  Chinese Virtual Observatory (China-VO) project is a consortium initiated by Chinese National Astronomical Observatory and Large Sky Area Multi-Object Fiber Spectroscopic Telescope project. A three-layer architecture of the China-VO is described, which depends upon the Open Grid Services

Architecture being developed by the Global Grid Forum. The fabric layer mainly consists of astronomical datasets with corresponding metadata and data access services. The resource layer includes a large scale of services for grid resource management, data interoperation, data mining, security, logical name space, and so on. The application layer consists of user interfaces and other client services. In the China-VO system, all the functional components are SOAP Grid service implementations.

Chinese National Grid (CNGrid) will be the testbed for the China-VO. How to interact with other CNGrid components is also discussed.

- **LAMOST Project and the Chinese Virtual Observatory**
  Zhao Y. - National Astronomical Observatories, and Cui C.

  Chinese Virtual Observatory (China-VO) is a consortium initiated by National Astronomical Observatories of China and Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST) project. The LAMOST project will survey more than ten million galaxies and stars to get their spectra after the telescope constructed. The huge volume of data set from LAMOST spectroscopic sky survey is very valuable for researches on wide field and large sample astronomy. An important task for China-VO is to make LAMOST scientific data services as VO-enabled. The input catalogs for the LAMOST spectroscopic survey will benefit from the abundant international astronomical archives interconnected through China-VO. The progress and roadmap of China-VO project will be introduced.

- **VO and Chinese Current Status, Developments**
  Lin, G.

  VO will affect astronomy enormously. Chinese astronomer is facing to VO's chance and challenge. In this paper, the author discusses relationships between Chinese current status, development in network, large telescopes, data and computer equipments and VO from macroscopical point of view. The author thinks CVO (China VO) will not only make contribution to Chinese astronomers but also to world astronomers.

- **Introduction of the Korean Virtual Observatory (KVO)**
  Kim S. C. - Korea Astronomy Observatory, and Sung H.-I., Kim B.G., Chun M.-Y., Park J.-H., Cho S.-H., Byun Y.-I., Koo B.-C.

  The Korean Astronomical Data Center (KADC) in Korea Astronomy Observatory (KAO), the national observatory of the Republic of Korea, has started its mission in 2002 and performed the principal axis in giving birth to the Korean Virtual Observatory (KVO) in February 2003. We have commenced building the KVO. About twenty members of astronomers and computer scientists took part in the KVO and we have annual fund of 100,000 USD till 2005. As a first mission of the KVO, we are constructing an initial version of KVO using data produced by telescopes in Korea, such as those from Taeduk 14m radio telescope, Bohyunsan Optical Astronomy Observatory 1.8m telescope, YSTAR (Yonsei Survey Telescopes for Astronomical Research)-NEOPAT (Near Earth Object PATrol) project, and Galactic plane CO survey (l=60-180) project using the Seoul National University 6m radio telescope. Data from telescopes that will be built in the

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

near future (e.g., Korean VLBI Network; KVN) and data from satellites being launched by international cooperation (e.g., Far-ultraviolet IMaging Spectrograph - FIMS - or Galaxy Evolution Explorer - GALEX) will also be used. We will show and discuss key aspects in building the KVO, including general plans and technical issues.

- **The Astrophysical Virtual Observatory AVO**
  P.J. Quinn - European Southern Observatory, and P. Benvenuti, P. Diamond, M. Dolensky, F. Genova, A. Lawrence, Y. Mellier

  The Astrophysical Virtual Observatory Project (AVO) is conducting a research and demonstration programme on the scientific and requirements and technologies necessary to build a VO for European astronomy. The Phase A program focuses its effort in three areas: First, a detailed description of the science requirements for the AVO is constructed following the experience gained in a smaller-scale science demonstration program called ASTROVIRTEL. Second, the difficult issue of data and archive inter-operability is addressed by new standards definitions for astronomical data and trial programmes of "joins" between specific target archives within the project team. Finally, the necessary GRID and database technologies are assessed and tested for use within a full AVO implementation. This already resulted in an AVO prototype system displayed at the common demo booth of the International Virtual Observatory Alliance (IVOA).

- **The German Astrophysical Virtual Observatory**
  W. Voges - Max-Planck-Institut für extraterrestrische Physic, and M. Steinmetz, H.-M. Adorf, H. Enke, G. Lemson

  The German Astrophysical Virtual Observatory (GAVO; `www.g-vo.org`) is a project led by the Max-Planck-Institut für extraterrestrische Physik, Garching, and the Astronomisches Institut Potsdam with the aim of triggering and coordinating Virtual Observatory activities in Germany. The long-term goal of GAVO consists in establishing a technologically advanced platform that supports astronomical research. GAVO pursues this goal by facilitating the exploitation of heterogeneous, distributed data archives from astronomical observations and from large-scale astrophysical simulations.

  A pilot project was proposed to the German Bundesministerium für Bildung und Forschung and, in October 2002, received funding for an initial period of 18 months. The main objectives of the GAVO pilot project are: (1) the federation of distributed, heterogeneous public astronomical archives; (2) the exploitation of GRID-computing for the next generation of large astrophysical simulations and as a platform independent system for distributed data analysis and cross-correlation; (3) the implementation of an advanced classification, tool called the "Next Generation Search Engine". Additionally, GAVO supports database curators in the process of publishing their data in a VO-compliant form. GAVO participates in the activities of the IVOA, and actively cooperates with other virtual observatory projects as well as industrial partners.

- **Japanese Virtual Observatory Project**
  Ohishi M. - National Astronomical Observatory of Japan, and Mizumoto Y., Yasuda N., Shirasaki Y., Tanaka M., Masunaga Y.

  The Japanese Virtual Observatory (JVO) project has been commenced as an observatory's project since April 2002. The JVO aims to provide federated astronomical databases (especially SUBARU, Nobeyama and ALMA) and data analysis environment through the Grid technology. The project has been performed under collaboration with the NAOJ, the Ochanomizu University and Fujitsu Ltd. Furthermore we have been collaborating with many information scientists in Japan, whose research interests are on the Grid technology. We already defined a unified query language to access astronomical databases the JVO QL, and constructed a prototype of the JVO to confirm if the JVOQL really works on a federated database through Grid technology. In the near future JVO will be connected with other VOs in the world through the International Virtual Observatory Alliance. We plan to demonstrate the JVO prototype at the IVOA demo booth.

- **Current Status of the Russian Virtual Observatory**
  O.Y. Malkov - Institute of Astronomy, and O.B. Dluzhnevskaya, E.Y. Kilpio, A.A. Kilpio, D.A. Kovaleva

  The Russian Virtual Observatory (RVO) has been officially recognized as one of the key projects of the Scientific Council on Astronomy of the Russian Academy of Sciences since December 2001.

  The ultimate goal of the RVO initiative is to integrate resources of astronomical data accumulated in Russian observatories and institutions, and to provide Russian data to the rest of the world.

  One of the principal goals of the project is to provide Russian researchers with on-line access to the rich volumes of data and metadata that have been and will continue to be produced by astronomical survey projects.

  RVO architecture, main tasks and roadmap are discussed in the presentation.

- **Astrogrid, the Virtual Observatory, and what it Isn't**
  A. Lawrence - Institute for Astronomy, University of Edinburgh

  The Virtual Observatory should do for astronomical databases what the WWW did for documents - to make them transparently available from your desktop, and easy to manipulate with a standard set of tools. The UK AstroGrid project aims at an early working implementation of this idea. The analogy with the Web is actually quite close. Our philosophy is that the VO should not be a software monolith or a bureaucratic structure, but simply an enabling framework. First and foremost this means a set of standards - not just for data, but for metadata, data exchange protocols, provenance, and so on. The programme of standards is developing internationally. AstroGrid itself aims to build a set of open source software components, analogous to Apache in the web world. We will build a first concrete working example, but the intention is actually that anybody can customize and adapt these components to build their own system. I will describe progress on building these components so far.

- **AstroGrid - Constructing the UK's Virtual Observatory**
  N.A. Walton - Institute of Astronomy, University of Cambridge, and A. Lawrence, A.E. Linde

  The UK AstroGrid Project (`http://www.astrogrid.org`) is one of three major world-wide projects (along with the European AVO and US-VO projects) which are creating an astronomical Virtual Observatory. This will be a set of co-operating and inter-operable software systems that:

  - allow users to interrogate multiple data centers in a seamless and transparent way;
  - provide powerful new analysis and visualization tools;
  - give data centers and providers a standard framework for publishing and delivering services using their data.

  AstroGrid's long term vision is not one of a single software package, but rather of a framework which enables data centers to provide competing and co-operating data services, and software providers to offer compatible analysis and visualization tools. Our presentation will describe (and illustrate with live demonstrations) how AstroGrid is developing a standardized framework to allow such creative diversity, which will:

  - improve the quality, efficiency, ease, speed, and cost-effectiveness of on-line astronomical research
  - make comparison and integration of data from diverse sources seamless and transparent
  - remove data analysis barriers to interdisciplinary research
  - to make science involving manipulation of large datasets as easy and as powerful as possible.

- **The U.S. National Virtual Observatory**
  R.J. Hanisch - Space Telescope Science Institute

  The U.S. National Virtual Observatory project is a development effort aimed at implementing the framework for an eventual Virtual Observatory facility. Project activities include the development of metadata standards, resource and service registries, table and image access protocols, interfaces to the computational grid, and access to VO resources for education and public outreach. Select science prototypes are used to guide technical development and demonstrate the capabilities of the VO framework for enhancing research. The US NVO project works closely with international VO partners through the International Virtual Observatory Alliance.

  The US NVO project is funded by the National Science Foundation under Cooperative Agreement AST0122449 with The Johns Hopkins University.

New projects, ideas, techniques and standards

- **Report of ALMA-Japan Activities for Virtual Observatory**
  Tatematsu K. - National Astronomical Observatory of Japan, and Nakanishi K., Sawada T., Kandori R., Morita K., Sunada K.

The Japanese side of the Atacama Larger Millimeter/submillimeter Array (ALMA-Japan) is making its efforts for Virtual Observatory, which will be one of the key functionalities of the ALMA Regional Support Center in Japan. We summarized our science requirements and science cases with priority ranking for VO from our expertise in radio astronomy at Nobeyama Radio Observatory, NAOJ. We are working on development of pipelines for the existing radio telescopes and near-infrared telescope to assess the data qualities which are suitable for pipeline data retrieval for Virtual Observatory. Because the average ALMA data rate is as high as 380 TB/yr, the data abstraction (i.e. making catalogue) of 3 dimensional data including diffuse line emission will be a key technology for efficient Virtual-Observatory astronomy with ALMA. We like to report the status report of our activity. The program is being carried out in collaboration with Astronomical Data Analysis Center, NAOJ.

- **Architecture of the AVO Prototype**
  M. Dolensky - European Southern Observatory, and M.G. Allen, K. Andrews, T. Boch, F. Bonnarel, S. Derriere, P. Fernique, M. Hill, M. Leoni, A.E. Linde, A. Micol, B. Pirenne, A.M.S.R. Richards, A. Schaaff, G. Tissier, N.A. Walton, A. Wicenec

  Europe's Astrophysical Virtual Observatory (AVO) developed a prototype system and continues to improve it. A board of 50 scientists - the AVO science working group - is advising the project team with the goal of maximizing the scientific return.

  In order to implement their recommendations a number of VO key technologies come into play. Each of the software components of the AVO prototype is developed and maintained by a different team in a different country. All modules work stand-alone, but can be integrated as shown at the IVOA demo booth. The AVO prototype consists of a browser backed by image and catalogue servers, a web service for the extraction of source catalogues and a utility for analyzing the spectral energy distribution of selected objects. The three components communicate in VOTable format - an XML dialect for Astronomy. Parameters (meta data) are mapped to Unified Content Descriptors (UCD). UCDs are about to become the standard way for expressing meta data in a VO. Finally, the integrated meta data browser is based on the IDHA data model.

- **Collaborative Astrophysical Research in AIRE**
  Zhou J. - Center for Astrophysics, Tsinghua University, and Qi R., Yang Y., Nie J.

  To study the complex universe effectively, collaboration among astrophysicists is necessary. The proposed AIRE (Astrophysical Integrated Research Environment) is to help astrophysicists do collaborative research efficiently. The AIRE consists of three main parts: a Data Archive Center (DAC) which collects and manages public astrophysical data; a web-based Data Processing Center (DPC) which enables astrophysicists to process the data in a central server at any place and anytime; and a Collaborative Astrophysical Research Project System (CARPS) with which astrophysicists in

different fields can exchange their ideas and organize international virtual research groups. A few examples will be demonstrated in this talk.

- **Design of the W.M. Keck Observatory Single Dish Archive**
  B. Berriman - California Institute of Technology, and N. Tahir-Kheli, T. Bida, A. Conrad, P. Kurpis, H. Tran

  The W. M. Keck Observatory will deploy an archive of observations made with the telescope operating in Single Aperture mode. When complete, the archive will enable scientific discovery through fusion of data from multiple instruments, and will enable detailed performance analysis of the Keck instruments. The archive will provide access to observations made on multiple instruments that meet complex criteria based on position in the sky and the attributes of the data (wavelength range, spectral resolution, etc). Its design takes advantage of emerging or proposed standards for describing and distributing complex data sets. By late 2004, the archive will serve observations made with the High Resolution Echelle Spectrometer (HIRES). The archive leverages a highly modular design implemented at the NASA/IPAC Infrared Science Archive (IRSA), in which thin front-end interfaces sit on top of an component based infrastructure.

- **Space-Time Coordinate Metadata for the Virtual Observatory**
  A.H. Rots - Smithsonian Astrophysical Observatory

  Space-time coordinate metadata is at the very core of understanding astronomical data and information. This aspect of data description requires very careful consideration. The design needs to be sufficiently general that it can adequately represent the many coordinate systems and conventions that are in use in the community. On the other hand the most basic requirement is that the space-time metadata for queries, for resource descriptions, and for data be complete and self-consistent. Among other things, it is important to keep space and time coordinates together - not only to account for relativistic effects but also to allow transformations and accommodate ephemerides information; to provide information, not only on the observation's coordinates, but also those of the telescope; to handle celestial as well as solar system coordinates; and to support the description of regions. The development of a complete description has been underway for about a year. At this point we are ready to present the definitive description of this metadata structure expressed as an XML schema.

  This work has been supported by NASA contract NAS 8-39073 (CXC) and by the University of Strasbourg.

- **Organisation of Datasets in Virtual Observatories**
  M.G. Allen - CDS, Observatoire de Strasbourg, and F. Bonnarel, T. Boch, P. Fernique, M. Louys, AVO Team

  Browsing and providing access to large local and distributed datasets is an important aspect of enabling Virtual Observatories. We present an example implementation of a meta-data tree in the Astrophysical Virtual Observatory prototype tool. This is a dynamically built "meta-data tree"

containing information on image datasets, based on the IDHA data model. This meta-data representation of the GOODS dataset in the AVO demo, allows efficient data browsing and selection. This capability is being developed in the framework of the CDS Aladin image browser, and AVO prototypes.

- **The unique classification systems UDC52 and Astronomy Thesaurus**
  T.N. Dorokhova - Astronomical Observatory of Odessa National University, and N.I. Dorokhov, O.B. Dluzhnevskaya

  Two systems for arrangement and ranking of an astronomical information are presented for discussion.

  1. UDC52 as class for astronomy of the Universal Decimal Classification. The UDC is one of the oldest and well-arranged language-independent classification scheme The Russian agency VINITI took an active part in the UDC development during almost half of century. As a result of this work every astronomical publication in the Russia, Ukraine and some other Former Soviet Union countries connects traditionally with definite classes and subclasses of UDC52 till present time. The revision of UDC52 was undertaken by G.Wilkins for the task of IAU Commission 5 but this project does not progress now.

  2. The Astronomy Thesaurus Project with the Multi-Lingual Supplement which was realized by R.M. and R.R. Shobbrook in cooperation with the librarians of different countries on the instructions of the IAU, Commission 5. We are presently carrying out the translation of the Astronomy Thesaurus into Russian and also into Ukrainian as an addition to the Multi-Lingual Supplement. This advisable list of terms with the definite hierarchy and relationship have demonstrated its usability for building and development of the NASA ADS retrieval service and for the revision of UDC52.

  Unfortunately, recently both of these perfectly arranged systems are not updated. The situation can be corrected with the attention and efforts of the World astronomical community. Both systems can be useful and advantageous for the Project of Virtual Observatory providing the reliable storage and retrieval of the information. Hopefully, that such project will promote involving a bulk of Russian and Ukrainian astronomical publications and data archives into existing World Data Networks.

- **XML in the Virtual Observatory**
  R.G. Mann - Institute for Astronomy, University of Edinburgh, and R. Baxter, P. Buneman, D. Byrne, R. Hutchison, C. Koch, T. Wen, M. Westhead

  XML is the lingua franca in the Web (and Grid) services world and so will play a major role in the construction of the Virtual Observatory. Its great advantages are its flexibility, platform-independence, ease of transformation and the wide variety of existing software that can process it. An obvious disadvantage in its use as an astronomical data format is its verbosity; the number of bytes taken up writing the XML tags can easily

outnumber those constituting the actual astronomical data. This becomes prohibitively inefficient when large amounts of data are stored in XML, and the developers of VOTable sought to circumvent this, by allowing for the use of binary data, either in the VOTable document itself or in an external file linked from it. The verbosity of XML in this regard is a problem in many other disciplines, and computer scientists are developing more generic solutions to that found in the VOTable specification. In this paper we describe several of these projects currently underway in Edinburgh, which focus on the compression and querying of XML, and a technology for representing the structure of a binary file in XML, enabling it to be read as if it were XML.

- **COSMO.LAB: Software for Stereographic Viewing**
  H.R. de Ruiter - Osservatorio Astronomico di Bologna

  A Virtual Observatory will have to deal with the problem of easy and quick data display. Most astronomical catalogs contain multi-dimensional data, but the common visualization packages only allow for displaying two dimensions at a time. This is now a severe and unnecessary limitation: modern day computer technology permits true 3D visualization at very low cost. A new software package (Cosmo.Lab) which can run under different operating systems (Linux, MSWindows) has been developed that makes stereographic vision easy, fast and user-friendly. The project, funded by the European Union, is at present in an advanced stage of completion. The software is able to handle very large data sets and manipulate the data (zooming, rotation, etc.) in real time. It can read gridded data as well as object lists extracted from astronomical catalogs. One of the strong points is the portability of the package on many different computer platforms ranging from (costly) virtual 3D theaters to (very cheap) personal computers. Finally we should mention that Cosmo.Lab is free ware, i.e. it can be freely down loaded from the Web page of CINECA. At request a CD-ROM is also available.

- **Automated Online Data Analysis by Artificial Neural Networks**
  H.P. Singh - Department of Physics, Sri Ventkateswara College, and R. Gupta

  Artificial neural networks (ANN) have been successfully used recently for automated stellar spectral classification of the UV, visible and the IR spectral databases. We propose to build an ANN based online data analysis pipeline in collaboration with VO India for the new INDO-US stellar spectral library of nearly 1300 stars from 3500-9500Åobserved from the KPNO Coude feed by Valdes et al. (2003). The paper discusses important ingredients of such a pipeline.

- **Object Classification with GAIA and Virtual Observatories**
  C.A. Bailer-Jones - Max-Planck-Institut für Astronomie

  The GAIA Galactic Survey Mission will be launched in 2010 by the European Space Agency to obtain microarcsecond precision astrometry and radial velocities of stars across the entire Galaxy. The resulting six dimensional phase space database (3 spatial, 3 velocity co-ordinates) will

be supplemented by 15 band optical photometry at many tens of epochs. This large complex database - comprising all one billion objects in the sky brighter than 20th magnitude - will be the basis for numerous scientific projects - such as investigating the merger history and chemical evolution of our Galaxy mapping its star formation history and searching for extra-solar planets - to significantly improve our understanding of stellar and galactic astrophysics. But to achieve this, an accurate classification of everything in the database (including QSOs, galaxies and solar system objects) will be required, as will a detailed determination of stellar parameters (effective temperatures, radii, metallicities etc.). I shall discuss various multidimensional data techniques which are being developed to address these problems. A number of the challenges we face are common to those faced by the Virtual Observatory projects, including combination of inhomogeneous data, object matching, efficient mining for objects types and variable criteria for object selection.

- **AstroGrid and the VOs: Science and Use in the ELT ERA**
  N.A. Walton - Institute of Astronomy, University of Cambridge

  In the new era of Extremely Large Telescope's (ELT), new science discoveries will come from the linkage of multi-wavelength data sets from a wide range of the 'best in class' facilities, e.g. James Webb Space Telescope (JWST), ALMA, ESO's OWL, etc. AstroGrid and the Virtual Observatory (VO) initiatives are providing the technical infrastructure to enable the seamless integration, mining and dissemination of these data.

  This presentation will highlight how major science programmes, such as the hunt and investigation of earth-like planets, will be facilitated by the use of Virtual Observatory systems in linking these, large, distributed, multi-sourced information and data streams.

  VO's will also impact on instrument design and use. By obtaining data from a multitude of sources, simultaneously through integrated VO-Observatory operations, specific ELT instruments could be designed to be much more specific in which data they acquire. A future operating model could see data acquisition programmes routinely delivering simultaneous data streams (e.g. rapid, multi facility observations of Gamma Ray Bursters) from instruments on e.g. ELT, ALMA, JWST, via the VO.

- **ASTROVIRTEL - a Precursor of the Virtual Observatory**
  P. Benvenuti - ESA/ESO, and A. Micol, F. Pierfederici, B. Pirenne

  ASTROVIRTEL, a small support programme for the utilization of large astronomical archives, is completing its 3rd Cycle. The experience in supporting a number of selected science projects has been very useful for deriving scientific requirements for the Virtual Observatory. A summary of the lessons learned is presented.

- **VO and KP for Massive Planetary Data Sets**
  P.A. Yanamandra-Fisher - Jet Propulsion Laboratory

  The concept for a National Virtual Observatory (NVO) is being realized for astrophysical data sets. A similar need exists for massive large planetary

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press

data sets from planetary missions and ground-based observations. Data returned from missions are organized into information data repositories such as the Planetary Data System (PDS) for NASA mission data; Space Telescope Science Institute (STScI) for Hubble Space Telescope (HST) data; SIRTF Science Center (SSC) for SIRTF, and other similar sites. However no such dedicated repository exists for the terabits of data collected by ground-based observers in support of various missions. Coordination of these data sets and providing analysis tools is necessary to allow the planetary astronomy community access for research and cross-correlative analysis. Towards this goal, we are developing a prototype suite of algorithms for ground-based data collected by our team in support of NASA's GALILEO and CASSINI missions to integrate multi-spectral and multi-instrument data. We have an end-to-end data pipeline from initial data processing to absolute calibration and products in between. Our goal is to develop a knowledge portal for content and an ancillary virtual observatory in support of established planetary data warehouses.

- **Adding Theory to the Virtual Observatory**
  S.T. Maddison - Swinburne University, and G.F. Lewis

  The Virtual Observatory is an ambitious plan to bring the world of astronomical data to everyone within a few simple keystrokes. There is significant international interest and funding for this project for which the observational component is very well established. The inclusion of theoretical data and models has yet to be tackled, and it is clear from the breadth of theoretical research that the Theory VO faces a lot of challenges. A unique component of the VO may be the provision of virtual telescopes, allowing mock observations of a synthetic universe. On behalf of the Australian National Institute for Theoretical Astrophysics, we present the current ideas and views of the Australian theoretical community concerning the implementation of theory as an integral part of the international virtual observatory.

- **Extending the Time Dimension of the IVO**
  R.E.M. Griffin - Dominion Astrophysical Observatory, Herzberg Institute for Astrophysics

  Most of the scientific visions for the International Virtual Observatory are focusing on digital datasets from major surveys, current or planned. Here we urge the inclusion of astrometric and spectroscopic datasets of historic observations.

  Despite their unprecedented high quality, modern observations are telescoped into brief time intervals that cannot contain the information on slow changes that is vital for refining orbits, proper motions or evolution studies. Whether we research supernova precursors, NEO orbits, post-helium-flash stars or long-period binaries, access to historic observations is of paramount importance. Such observations exist, but they are photographic and are presently not easily accessible. Digitizing projects, now fully feasible, can bring their information into the public domain and into the IVO. Re-working the past does not imply re-doing the science of the

day; observations can be re-used for science never contemplated by the original observers.

The inclusion of data from 30-100+ years ago will furnish an important extra dimension to the new 3D research of the cosmos promised by the IVO. Some plate-scanning has already commenced. The creation of accessible digital datasets from historic observations is a minuscule operation compared to the IVO which they will undoubtedly enhance. It deserves and seeks the IVO's support.

- **The Contribution of the Wide-Field Plate Database to the International Virtual Observatory**
  M. Tsvetkov - Sofia Sky Arcive Data Center, Institute of Astronomiy, Bulgarian Academy of Sciences

  The development for the period 2000-2003 of the Wide-Field Plate Database (WFPDB, `http://www.skyarchive.org`) as an initiative of the IAU Working Group on Sky Surveys, hosted by Commission 9, is presented. The new version of the Catalogue of the Wide-Field Plate Archives contains descriptive information for practically all existing professional wide-field photographic observations stored in 365 archives around the world. The total number of plates, made since the end of the 19th century by the help of more than 200 telescopes, is over 2 000 000. Currently the WFPDB provides access to the information for about 640 000 plates from 117 plate archives, i.e. about 30% of the estimated archive total number. Following the directions of the Centre de Données Astronomiques de Strasbourg (CDS) and International Virtual Observatory (IVO) the WFPDB contains the digitized plate preview images, as well as digitized plate row data obtained by the new generation of the flatbed scanners. The WFPDB team continues to enlarge the database with submitted or retrieved information from the photographic plates, which enable the astronomical community to complement "the digital sky" with data going more than 100 years back in time.

- **Bamberg Southern Photographic Patrol Survey: Incorporation in the WFPDB**
  M. Tsvetkov - Sofia Sky Archive Data Center, Institute of Astronomy, Bulgarian Academy of Sciences, and K. Tsvetkova, A. Borisova, D. Kalaglarski, R. Bogdanovski, U. Heber, I. Bues, H. Drechsel, R. Knigge

  The description, cataloging and incorporation into the Wide Field Plate Database (WFPDB, `http://www.skyarchive.org`) of the Dr. Remeis-Observatory Bamberg Southern Photographic Patrol Survey (22 000 plates) is presented. The survey was carried out with 22 cameras (each with d=10 cm), Zeiss camera (d=7cm), and the Harvard telescopes Metcalf (10=94) and Ross B (3=93). The plates were obtained in the period 1963-1976 in Boyden Observatory (South Africa), Mount John University Observatory -Lake Tekapo (New Zealand) and San Miguel Observatory (Argentina) and are stored at present in the Observatory stacks. The observational programme was supported by the Deutsche Forschungsgemeinschaft (DFG) and carried out under the supervision of W. Strohmeier (1965, Kleine

Veroeff. der Remeis-Sternwarte Bamberg, Bd. IV, No. 40, p. 302). Digital CCD preview images of the plates by observational zones are, for the first time, included into the WFPDB providing access to them for the worldwide astronomical community. Special attention is paid to the sub-survey in the LMC region. The digitization of plates at the Bamberg Observatory will become possible soon with the installation of an EPSON Expression 1640XL flatbed scanner granted by DFG.

- **Digitization of Archives of Astronomical Plates**
  A. Omizzolo - Vatican Observatory Research Group, and B. Cesare, C. Blanco, B. Bucciarelli, A. di Paola, R. Nesci

  The photographic plate archives of telescopes around the world contain a veritable treasury of astronomical data. Unfortunately the emulsion is a volatile support and full exploitation of the scientific content is more and more difficult. A large-scale two-year project to digitize the archive of plates of the Italian Astronomical Observatories and of the Specola Vaticana has been started in 2002 with funds from the Ministry of the University and Research, following a pilot program funded by the University of Padova in 2001. Identical systems, composed by a high quality commercial scanner plus dedicated personal computers and acquisition software (developed initially at DLR Berlin) have been installed in all participating Institutes. Three main goals make up the total project: to provide high quality photometric sequences with the Campo Imperatore telescopes to be used on the scanned plates, to perform astrometric measures taking advantage of the large span of time covered by the plates, and to distribute the digitized information to all interested researchers via the international Web. This paper presents some of the activities carried out and results obtained so far.

https://doi.org/10.1017/S1539299600015781 Published online by Cambridge University Press