Astrophysics and Space Science Proceedings

Wayne Orchiston Tsuko Nakamura Richard Strom *Editors*

Highlighting the History of Astronomy in the Asia-Pacific Region Proceedings of the ICOA-6 Conference



About the Authors



Stella Cottam was born in New York City (USA) in 1949, and has B.S. degrees in physics and medical technology from Fordham University and the University of Nevada respectively, an M.S. in library science from the University of Kentucky and a Master of Astronomy from the University of Western Sydney in Australia. She works as a microbiologist at the Veteren's Administration Hospital in Lexington, Kentucky (USA). Stella is currently studying part-time for a Ph.D. through the Centre for Astronomy at James Cook University. Her thesis topic is "Solar Eclipses and Transits of Venus, 1868–1882, and their Role in

the Popularisation of Astronomy in the USA", and her supervisors are Wayne Orchiston and Richard Stephenson.



Steven Gullberg was born in Jamestown, New York (USA) in 1956, and has a B.S. from the State University of New York and a Master of Liberal Studies (Ancient Astronomy) from the University of Oklahoma. In 2009 he graduated with a Ph.D. from James Cook University with a thesis on "The Cosmology of Inca Huacas", supervised by "Kim" Malville and Wayne Orchiston. A former American Airlines pilot, Steven is currently involved in setting up a new national airline for Barbados. His astronomical interests focus mainly on Babylonian

astronomy and Incan archaeoastronomy. A paper based on his thesis research (and co-authored by Kim Malville) was published in Astronomy and Cosmology in Folk Traditions and Cultural Heritage, *Archaeologia Baltica*, 10, and another paper appeared in *The Journal of Cosmology*, volume 9, in 2010.

W. Orchiston et al. (eds.), *Highlighting the History of Astronomy in the Asia-Pacific Region*, 631
Astrophysics and Space Science Proceedings, DOI 10.1007/978-1-4419-8161-5,
© Springer Science+Business Media, LLC 2011

Ihsan Hafez was born in Beirut (Lebanon) in 1968. He has B.Sc. and M.Sc. degrees from the American University in Beirut and Boston University respectively and a Master of Astronomy from the University of Western Sydney in Australia. He works as a Manager in the refrigeration industry in Beirut. Ihsan founded the Middle East's only science and astronomical magazine, *Ilm Wa Alam*, and also the observatory at the Beirut Arab University, where he teaches undergraduate astronomy part-time. His research interests lie primarily in Arabic astronomy, and he has just completed a Ph.D. through the Centre for Astronomy at James Cook University. His thesis



topic was "Abdul-Rahman al-Şūfī and *The Book of the Fixed Stars*: A Journey of Rediscovery", and his supervisors were Richard Stephenson and Wayne Orchiston.

J. McKim ("Kim") Malville was born in San Francisco in 1934, and has a B.S. from Caltech and a Ph.D. from the University of Colorado. He has taught at the Universities of Michigan, Sao Paulo, and Colorado, where he was Chairman of the Department of Astro-Geophysics. He is currently Emeritus Professor of Astrophysical and Planetary Sciences, University of Colorado, an Adjunct Professor in the Centre for Astronomy at James Cook University (Australia), and a Tutor at the University of Lampeter, where he is teaching a graduate course in archaeoastronomy for the



Sophia Center. His research interests range from auroral physics, solar physics (radio astronomy, corona, flares) and archaeoastronomy (Peru, Egypt, India, and the American Southwest). Books that he has authored or edited include *Prehistoric Astronomy in the Southwest, Time and Eternal Change, A Feather for Daedalus, Ancient Cities, Sacred Skies: Cosmic Geometries and City Planning in Ancient India*, and *Pilgrimage: Self-Organization and Sacred Landscapes*. He is an Executive Editor of the on-line publication *Journal of Cosmology*.



Tsuko Nakamura was born in Seoul in 1943, during the Japanese colonization of Korea, and has Masters and Ph.D. degrees from the University of Tokyo. He is currently Professor of Information Sciences at Teikyo-Heisei University, and was formerly an Associate Professor at the National Astronomical Observatory of Japan in Tokyo. Tsuko is a member of IAU Commissions 20 (Positions and Motions of Minor Planets, Comets and Satellites) and 41 (History of Astronomy). He is also on the Editorial Board of the *Journal of Astronomical History and Heritage*. His main research interests lie in the size distribution of

small asteroids and comets, and the pre-modern history of Asian astronomical instruments and star maps. He is the author of numerous research papers in the above two fields, and the following books: *General Catalogue of the Japanese Astronomical and Land-surveying Books before 1870* (2005), *History of Cosmovison and Science* (2008), and *Japanese Astronomers of the Edo Period* (2008), all of which are in Japanese.



NHA II-Seong was born in Seongjin City (North Korea) in 1932, and has B.Sc. and M.S. degrees from Yonsei University and a Ph.D. in astronomy from the University of Pennsylvania. He is Professor Emeritus at Yonsei University, a former President of IAU Commission 41 (History of Astronomy) and Chair of the IAU Working Group on Historical Instruments, and is on the Editorial Board of the *Journal of Astronomical History and Heritage*. He is one of those who initiated the International Conference on Oriental Astronomy (ICOA), and is the founder of the Nha II-Seong Museum of Astronomy in Yecheon, Korea. His

main research interests lie in the history of East Asian astronomy and in photometric properties of eclipsing binaries, and he has more than 200 publications, including the following history of astronomy books: *Oriental Astronomy from Guo Shoujing to King Sejong* (1997, co-edited by Richard Stephenson), *History of Korean Astronomy* (2000, in Korean), *The Story of Solar and Lunar Eclipses* (2002, in Korean, co-authored by Lee Jung-bok), *Astronomical Instruments and Archives From the Asia-Pacific Region* (2004, co-edited by Wayne Orchiston, Richard Stephenson and Suzanne Débarbat) and *Murals of Four Holy Animals* (2008, co-authored by Sarah Nha). Currently, Il-Seong is in the process of writing a multivolume history of astronomy in Korea.

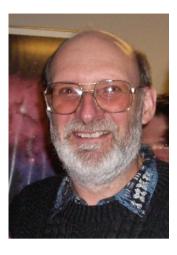
NHA Sarah was born in Philadelphia (USA) in 1971, and has B.Sc. and M.S. degrees from Yonsei University (Korea). Following her father's lead, she has research interests in eclipsing binaries and the history of astronomy. She is a member of the IAU Working Group on Historical Instruments, and was responsible for setting up and developing the Working Group's web site.



Yukio Ôhashi was born in Japan in 1955, and obtained a B.Sc. in physics and an M.A. in Chinese culture from Saitama University (Japan) in 1979 and 1981 respectively, and a Ph.D. in history of mathematics from Lucknow University (India) in 1992. He also completed the doctorate course of Hitotsubashi University (Japan) in Social Studies (Social History of the East) in 1989. He is a member of IAU Commission 41 (History of Astronomy). His main research interest is the history of astronomy in the East, and his publications include chapters in the following books: Kim Yung Sik and Bray, F. (eds.), 1999. Current Perspectives in the History of Science in East Asia; Selin, H. (ed.), 2000. Astronomy Across Cultures. A History of Non-Western Astronomy; Ansari, S.M.R. (ed.), 2002.



History of Oriental Astronomy; Chan, A.K.L. et al. (eds.), 2002. Historical Perspectives on East Asian Science, Technology and Medicine; Orchiston, W. et al. (eds.), 2004. Astronomical Instruments and Archives from the Asia-Pacific Region; Jiang Xiaoyuan (ed.), 2005. History of Science in the Multiculture: Proceedings of the Tenth International Conference on the History of Science in East Asia; Chen, K.-Y., Orchiston, W., Soonthornthum, B., and Strom, R. (eds.), 2006. Proceedings of the 5th International Conference on Oriental Astronomy; and Narlikar, J.V. (ed.), 2009. Science in India (History of Science, Philosophy and Culture in Indian Civilization, Volume XIII, Part 8).



Wavne Orchiston was born in Auckland (New Zealand) in 1943, and has B.A. (Honours) and Ph.D. degrees from the University of Sydney. He is currently an Associate Professor of Astronomy at James Cook University, Townsville, Australia. A former Secretary of IAU Commission 41 (History of Astronomy), he is the founder and former Chair of the IAU Working Group on Historic Radio Astronomy and is also on the Committee of the IAU Working Group on Transits of Venus. In addition to Commission 41, he is a member of IAU Commissions 40 (Radio Astronomy) and 46 (Astronomy Education and Development). He is the founding Editor of the Journal of Astronomical History and Heritage. Wayne's research interests lie mainly in

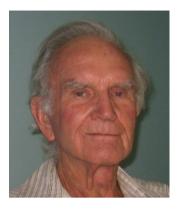
astronomical history, astronomical education and meteoritics, and he has more than 200 publications, including the following books: *Nautical Astronomy in New Zealand. The Voyages of James Cook* (1998), *Astronomical Instruments and Archives From the Asia-Pacific Region* (2004, co-edited by Richard Stephenson, Nha II-Seong and Suzanne Débarbat), *The New Astronomy: Opening the Electromagnetic Window and Expanding our View of Planet Earth* (2005, editor), *Proceedings of the 5th International Conference on Oriental Astronomy* (2006, co-edited by Kwan-Yu Chen, Boonrucksar Soonthornthum and Richard Strom) and *Foundations of Australian Radio Astronomy. A New Picture of the Southern Sky* (2011, co-authored by Woody Sullivan).



John Pearson was born in 1947 in the USA, and has a B.Sc. (Physics) from Redlands University, a Master of Communication and Library Science (California State University) and a Master of Astronomy from the University of Western Sydney (Australia). In 2009 John graduated with a Ph.D. from James Cook University (Townsville, Australia) with a thesis on "The Role of the 40 Foot Schaeberle Camera in the Lick Observatory Investigations of the Solar Corona", supervised by Wayne Orchiston and "Kim" Malville. He is retired, and lives in Rancho Mirage, California

(USA). His primary research interests are in the history of solar astronomy and in historic telescopes and other instruments. He is a member of the Antique Telescope Society. In 2008 his paper on "The 40-foot solar eclipse camera of the Lick Observatory" (co-authored by Wayne Orchiston) appeared in the *Journal of Astronomical History and Heritage*.

Bruce Slee is one of the pioneers of radio astronomy. He was born in Adelaide (Australia) in 1924, and received B.Sc. (Honours) and D.Sc. degrees from the University of New South Wales in 1959 and 1971 respectively. He is currently an Honorary Fellow at the CSIRO Division of Astronomy and Space Science in Sydney and an Adjunct Professor in the Centre for Astronomy at James Cook University, Townsville (Australia). He is a member of IAU Commissions 40 (Radio Astronomy) and 41 (History of Astronomy), and the IAU Working Group on Historic Radio Astronomy. He independently detected solar radio emission during WWII, was one of the original discoverers



of the first discrete radio sources, participated in the first metre-wave all sky surveys, and along with Bernard Lovell pioneered the investigation of radio emission from stars other than the Sun. His other research interests include scattering in the interplanetary medium, absorption in the interstellar medium, pulsar research, surveys of clusters of galaxies, and radio relics in clusters. He continues to carry out research on active stars, microquasars and clusters of galaxies, and has also published a succession of papers on the history of Australian radio astronomy, mainly in collaboration with Wayne Orchiston and his James Cook University Ph.D. students. [Editors' note: We are pleased to report that all four 2005–2006 issues of the *Journal of Astronomical History and Heritage* were dedicated to Bruce Slee, in recognition of his remarkable 60-year involvement in world radio astronomy.]

Mitsuru Sôma was born in Kuroiso (Tochigi Prefecture, Japan) in 1954, and has M.Sc. and Ph.D. degrees in astronomy from the University of Tokyo. He is currently an Assistant Professor at the National Astronomical Observatory of Japan. Mitsuru is an Organizing Committee member of IAU Commission 41 (History of Astronomy). He is also a member of IAU Commissions 4 (Ephemerides), 6 (Astronomical Telegrams), 8 (Astrometry) and 20 (Positions and Motions of Minor Planets, Comets and Satellites). In addition he is also a Vice President for Grazing Occultation Services of the International Occultation Timing Association. His research interests include linkage of stellar reference frames with dynamical reference



frames using observations of lunar occultations and changes in the Earth's rotation during ancient times using ancient records of eclipses and occultations.



Richard Stephenson was born in England in 1941, and has a B.Sc. (Honours) degree from the University of Durham, and M.Sc., Ph.D. and D. Sc. degrees from the University of Newcastle upon Tyne. He is currently an Emeritus Professor in the Department of Physics at the University of Durham and an Adjunct Professor in the Centre for Astronomy at James Cook University, Townsville (Australia). Upon his retirement from Durham University he was awarded a Leverhulme Emeritus Fellowship in order to continue his research. A

former President of IAU Commission 41 (History of Astronomy), Richard is also a member of Commission 19 (Earth Rotation), and he is on the Editorial Boards of both the Journal for the History of Astronomy and the Journal of Astronomical History and Heritage. He is widely recognized as the founder of the specialist field of Applied Historical Astronomy, and uses ancient records from Babylon, China, Japan, Korea, the Arabic world and Europe to investigate historical variations in the Earth's rotation, historical supernovae, the past orbit of Halley's Comet, solar variability and historical aurorae. He has also carried out considerable research on ancient Asian astronomical manuscripts and star maps. For his work in historical astronomy he was awarded the Jackson-Gwilt Medal by the Royal Astronomical Society and the Tompion Gold Medal by the Worshipful Company of Clockmakers (London), and minor planet 10979 has been named Fristephenson. Richard has more than 200 publications, including the following books: Atlas of Historical Eclipse Maps: East Asia, 1500 BC-AD 1900 (1986, co-authored by M.A. Houlden), Secular Solar and Geomagnetic Variations Over the Last 10,000 Years (1988, co-authored by Arnold Wolfendale), Oriental Astronomy from Guo Shoujing to King Sejong (1997, co-edited by Nha II-Seong); Historical Eclipses and Earth's Rotation (1997), Historical Supernovae and their Remnants (2002, co-authored by David Green) and Astronomical Instruments and Archives From the Asia-Pacific Region (2004, co-edited by Wayne Orchiston, Nha Il-Seong and Suzanne Débarbat).



Ronald Stewart was born in Gordonvale (Queensland) in 1939, and has a B.Sc. (Honours) degree in physics (University of Queensland), a Master of Teaching degree (University of Technology, Sydney) and a Ph.D. in history of astronomy (James Cook University, Queensland). He was a Principal Research Scientist with the CSIRO's Division of Radiophysics working in solar radio astronomy before joining the Australia Telescope in 1986 where he worked in galactic and stellar radio astronomy. He also spent time as a visiting astronomer at the University of Hawaii

in 1972, the University of Colorado (Boulder) in 1981 and the Naval Research Laboratory (Washington, DC) in 1983. He left CSIRO in 1996 to teach secondary school science, and retired in 2006. Ron is a member of IAU Commission 40 (Radio Astronomy) and the IAU Working Group on Historic Radio Astronomy, and is currently researching the history of Australian radio astronomy in collaboration with Wayne Orchiston and Bruce Slee.

Richard G. Strom was born in New York City (USA) in 1944, and has a B.A. in physics from Tufts University (USA) and M.Sc. and Ph.D. degrees in radio astronomy from the University of Manchester (Jodrell Bank), UK. Until his retirement in 2009 he was Senior Research Astronomer at ASTRON (the Netherlands Institute for Radio Astronomy) in Dwingeloo, and Adjunct Professor of Astronomy at the University of Amsterdam. In 2010 he holds a Chinese Academy of Sciences Visiting Professorship for Senior International Scientists, and has been a Visiting Professor of Physics at the National University of Singapore. He is also an Adjunct Professor in the Centre for Astronomy at James Cook University,



Townsville (Australia). Richard is a past Secretary and member of the Organising Committee of IAU Commission 40 (Radio Astronomy), and is also a member of Commissions 28 (Galaxies), 34 (Interstellar Matter) and 41 (History of Astronomy) and of the IAU Working Group on Historic Radio Astronomy. He is on the Editorial Board of the *Journal of Astronomical History and Heritage*. His research interests include supernova remnants, pulsars, large radio galaxies, radio polarimetry and interferometry, historical Chinese astronomical records and the history of radio astronomy in the Netherlands. He has numerous publications in a range of astronomical journals, and the history of astronomy book, *Proceedings of the 5th International Conference on Oriental Astronomy* (2006, co-edited by Kwan-Yu Chen, Wayne Orchiston and Boonrucksar Soonthornthum), in addition to co-editorship of the present *ICOA Proceedings*.



Kiyotaka Tanikawa was born in Gamago-ori (Japan) in 1944, and has M.Sc. and Ph.D. degrees in astronomy from the University of Tokyo. He is now a Special Visiting Scientist at the National Astronomical Observatory of Japan (NAOJ) following his retirement. He first had a post as an astrolabe observer at the International Latitude Observatory of Mizusawa (ILOM) in 1978 and stayed there until 1990. In 1988, there was a reorganization of Japanese astronomical institutes and the ILOM and Tokyo Astronomical

Observatory of the University of Tokyo united to become the National Astronomical Observatory of Japan. Kiyotaka moved from Mizusawa to Tokyo in 1990 and began his career as an astronomer by making and analyzing CM diagrams of globular clusters before changing to theoretical studies: the restricted three-body problem, Solar System dynamics and chaotic dynamics in two-dimensional maps. In 1995 he added the general three-body problem to his research, and introduced numerical symbolic dynamics into this field. In 2001, he turned to history of astronomy when he began investigating historical changes in Δ T. Now he enthusiastically promotes the scientific study of ancient east Asia using the astronomical data that accumulated there.



Mayank Vahia was born in Bhuj (India), in 1956, and has B.Sc. and Master of Physics degrees from the University of Mumbai (India). He is currently a Professor in Tata Institute of Fundamental Research in Mumbai. He has worked on several projects involving Indian satellites flown on Indian, Russian and American missions to study high energy emission from the Sun and other objects. He has more than 190 publications in most of the major journals in astronomy and astrophysics as well as computer science. Mayank is a member of the IAU Commissions 41 (History of Astronomy) and 44 (Space and High Energy

Astrophysics). For the past 4 years he has been researching the origin and growth of astronomy in the Indian subcontinent and has published more than half a dozen papers on the subject, including one in the *Journal of Astronomical History and Heritage*.

Harry Wendt was born in Angaston (Australia), in 1962, and has a B.Sc. (Honours) from the University of Technology (Sydney) and a Master of Astronomy from the University of Western Sydney (Australia). He currently works in a senior management role in the banking industry in Sydney, but has maintained a lifelong interest in astronomy, and particularly the history of radio astronomy. He is a member of the IAU Working Group on Historic Radio Astronomy. In 2009 he graduated with a Ph.D. from James Cook University. His thesis topic was "The Contribution of the C.S.I.R.O. Potts Hill and Murraybank Field Stations to International Radio Astronomy", and he was supervised by Wayne Orchiston and Bruce Slee. A number of papers based on his thesis



research (sometimes co-authored by Wayne Orchiston, Bruce Slee and other members of the history of radio astronomy group at James Cook University) have appeared in the *Journal of Astronomical History and Heritage* and in *Publications of the Astronomical Society of Australia*.

Nisha Yadav was born in Mumbai (India) in 1983. She is a graduate in physics (2003) from Mahatma Gandhi University, Kottayam (Kerala, India) and is pursuing her Ph.D. in computer science at Mumbai University. She is a scientist at the Tata Institute of Fundamental Research, and has published more than ten papers on computer science and history of science in major Indian and international journals. Nisha has largely worked on various aspects of Harappan Civilisation and its script, and she has wide-ranging interests in the origin and growth of astronomy in India.



Tadato Yamamoto was born in Yokohama (Japan) in 1974, and has an M.Sc. (2000) from Kyoto Sangyo University and a Ph.D. (2004) in celestial mechanics from the Graduate University for Advanced Studies. He held a Post-doctoral Fellowship by Kyoto University between 2004 and 2007, and was one of the editors of *Proceedings of the Second Symposium on "History of Astronomy"* which was held in Kyoto on 19–20 December 2008. In 2008 Dr Yamamoto left astronomy, and he now works in a computer software company.





Seiko Yoshida was born in Hokkaido (Japan) in 1952, and had a B.Sc. in physics from Hirosaki University and an M.S. in history of science from Hokkaido University. After investigating relations between the Japanese anti-relativist Uzumi Doi and the Japanese physics circle during the 1920s, she became interested in the interaction between physicists and astronomers in Japan. She has especially focused on Kiyotsugu Hirayama, an astronomer sandwiched between two generations, his astronomical achievements, and the dynamics of the network of physicists and astronomers around him. Seiko has published three papers (in

Japanese) about Hirayama in *Kagakusii Kenkyu*. She lives in Sapporo city, works as a researcher in science-technology studies at the Graduate School of Agriculture in Hokkaido University (Sapporo), and teaches history of science at the Muroran Institute of Technology.

Index

A

Abacus, 155 Abbé Lacaille, 236 Abbot, C.A., 260 Abbot, C.G., 259, 300 Abney, Captain, 327 Absorption, 189, 259, 272, 277, 301, 424, 435, 461, 462, 467, 503, 505, 595 Absorption lines, 462, 595 Adams, C.E., 265, 309, 311 Adelaide (Australia), 227, 309, 311, 312 Adud al-Dawla, 122 Aerial, 382-386, 391-393, 401, 402, 404-406, 408-411, 414, 416, 420, 421, 435-447, 450, 452, 454, 483-486, 492, 493, 495, 498, 513, 522, 528, 531-533, 547-554, 556-558, 563, 565, 570, 571, 576, 577, 579, 595, 597-599, 601, 603, 604 Aerial beam, 404, 408, 409, 416, 421, 565, 597 Agricultural societies, 112 Agriculture, 88 Aguas Calientes (Peru), 92, 95 Aircraft propeller feather motor, 438 Air navigation, 436, 555, 605 Airy, G.B., 226, 257, 341 Aitken, Robert G., 247, 265, 266, 316-318, 320, 323, 331 al-Battāni, 122, 137 al-Bīrūnī, 123 Albrecht, S., 265, 299-301 Alcor, 137 al-Dainaouri, 122 Alexander, E., 368, 617 Alfonsine tables, 123 Alhama (Spain), 256, 262, 264, 291-295 Allen, Claborn, 225, 227

Allen, L.B., 265, 307, 502, 504 Almagest, 6, 122, 123, 125, 133, 136, 138 al-Şūfī, A.-R., 121-138 Altars, 95, 96, 100-102 Alt-azimuth mounting, 439 Alvan Clark and Sons, 251 Amalgamated Wireless Australia (AWA), 548 Amateur astronomers, 265 America, 234, 271–274, 331, 362, 369, 371, 623 American Astronomical Society, 314, 414, 540.555 Amplifiers, 383, 406, 442, 559 Andromeda, 59, 123, 136, 137, 405 Andromeda Nebula (M31), 405 Andō Yūeki, 159 Annual Review of Astronomy and Astrophysics, 539,603 Annular eclipse, 14, 33 Anomalistic month, 158, 160, 162 Antenna, 406, 420, 442, 512, 527, 534, 552, 554, 576, 582, 592, 596 Aperture synthesis, 422, 558, 582, 619 Apogee, 155, 157, 158, 162 Appleton, Sir Edward, 618, 623 Appulse of Mars and Jupiter, 148-149 Appulses of planets, 140, 149 Aprok River (China), 46, 47 Arabic astronomy, 121, 122, 137 Archaeoastronomy, 62 Archaeology, 61 Arequipa (Peru), 278 Arietis-Cetus region, 69 Artificial satellites, 4 Aryabhata, 78 Asia, 31, 35, 75, 76, 155, 179, 199, 219, 220,

227, 239, 548

Asteroid families, 171-194 Asteroids, 172-182, 188, 189, 192, 193 Astrolabe, 123 Astrology, 66, 67, 73, 76, 78, 123, 154 Astrometry, 178 Astronauts, 613 Astronomer, 5, 6, 9, 13, 16, 22, 23, 26, 54, 76, 78, 80, 122, 123, 130, 132, 136, 137, 142, 148, 159, 160, 168, 175, 176, 178, 179, 181, 185, 186, 188-193, 203, 204, 210, 216, 225-228, 236-239, 244, 245, 247, 249, 256, 258, 259, 261, 263, 265, 268, 269, 271, 273, 274, 278, 279, 282-285, 295, 305, 309, 312, 316, 317, 322-324, 326-328, 332, 341, 348-350, 355, 356, 359, 364, 367, 369, 370, 380, 415, 421, 424, 527-540, 548, 592, 594, 595, 604, 605, 607, 611, 615 Astronomical constants, 160 Astronomical Journal, 173, 193, 280, 414, 416, 419, 454 Astronomical observations, 53, 67, 73, 140, 154, 213, 272, 364 Astronomical records, 22, 53-57, 140-149, 151, 190-192, 209-221, 237 Astronomical Society of Australia, 539 Astronomical Society of the Pacific, 176, 266, 323, 326 Astronomical unit, 226, 234, 239 Astrophysical Journal, 416, 545 Astrophysics, 172, 177, 190, 194, 260, 539, 623 Asuka (Japan), 145, 146, 150 Aswan (Egypt), 262, 265, 295-296 Atharva Veda, 72 Athens (Greece), 13, 15 Atmospheric absorption, 272, 595 Attwood, C., 523, 532, 536, 621 Auckland Islands (NZ), 238 Aurorae, 140, 141, 211, 218 Ausengate, 103, 104 Australia, 227, 233, 235, 239, 262, 263, 265, 298, 308-316, 379, 380, 391, 394, 401, 402, 421, 424, 425, 473, 481, 482, 523, 535, 539, 547, 548, 551, 555-557, 562, 563, 572, 590, 595, 603, 606, 613, 618 Australian Aborigines, 309, 311, 312 Australian Academy of Science, 540 Australian Journal of Physics, 414, 418 Australian Journal of Scientific Research, 405, 412, 552, 563, 564 Australia Telescope Compact Array, 473, 539, 582 Austria, 227

R

Babylonian astronomical records, 6 Babylonian astronomy, 6 Badgerys Creek Field Station (Australia), 406, 422 Baghdad (Iran), 16, 122 Bailey's beads, 319 Baily, F., 257, 278, 340, 354, 362, 363 Baily, F. [Arequipa], 278 Bairnsdale (Australia), 553 Ball, Sir Robert, 329, 379 Bankstown Aerodrome, 380 Barnard, E.E., 250, 263, 267-270, 272, 323, 328 Bartlett Springs (California), 262, 263, 266-271 Basins, 95 Baumbach-Allen coronal density model, 502 Beamwidth, 382, 396, 407, 408, 440, 445, 450, 512 Beard, M., 447 Bell Telephone Laboratory (USA), 603 Bernabe' Cobo, 86 Bibliotheque Nationale (Paris), 129, 130 Big Bang, 435 Bigelow, F.H., 249, 329 Biggs, A.B., 237, 238 Big Pulkova Radio Telescope, 621 'Big science' projects, 380, 421, 425 Billings, B., 555 Birds, 237, 443 Blaauw, A., 190, 418, 419, 463 Black-drop effect, 226 Blum, E.-J., 619, 620 Bodleian Library (Oxford), 129, 130 Boischot, A., 423, 425, 506, 514, 611, 615, 621 Bolometer, 260, 300 Bolton, J., 380, 402, 405, 408, 410, 424, 434, 438, 439, 483, 494, 544, 551, 562, 594, 595,605 Bombay (India), 63, 280, 281, 359 Bongseon Temple, 204, 206 'Book of the Fixed Stars', 121-138 Boss, B., 265, 297 Boulders, 112 Bowen, E.G. ('Taffy'), 401, 434, 437, 490, 527, 536, 544, 545, 547, 548, 557, 564, 589, 590, 593, 606 Bracewell, R.N., 408, 553, 554, 561, 571, 572, 621 Brahe, T., 54 Brashear, J.A., 250, 254, 255, 265, 268, 279, 305, 306, 308, 318 Bray, Captain, 88, 263, 275, 278

- Brightness temperature, 399, 401, 412, 413, 450–453, 457, 463, 466, 564, 566, 573, 616
- Brihad Samhita, 78
- Brisbane (Australia), 387, 389, 556
- Britain, 226, 227, 341, 380, 425
- British Government, 280
- British Museum (London), 6, 7
- Broten, N., 619, 620
- Brouwer, D., 175, 176, 192, 193
- Brovary (Russia), 261, 262, 265, 302–304 Brown, E.W., 45, 178–180, 188, 189, 193,
- 278, 380, 406, 422, 578, 597 Buchanan, A.H., 264, 285
- Bunsen, R.W., 259
- Burke, B., 263, 290, 416, 420, 441, 442
- Burkhalter, C., 366
- Burnham, S.W., 263, 271–273, 323, 327
- Burzaham (India), 68, 70
- Butterfly condensers, 483, 484
- Buwavhid Dvnastv. 122

С

Ca II observations, 462, 468 Cairo (Egypt), 16, 123, 129, 265, 283, 295 Calendar-making, 74, 154, 179 Calendars, 71, 78, 154, 156, 159-160, 179, 191 Calibration system, 444 California Institute of Technology (USA), 434 camay, 87-89, 91 Cambridge (England), 193, 283, 328, 360, 380, 391, 403, 406, 422, 424, 540, 572, 592, 597, 603, 607 Cambridge 2C survey, 410 Camera, 227, 245-252, 254, 259, 267, 268, 270-281, 283-293, 295, 296, 298-303, 306-313, 317, 319, 323-325, 327, 329, 384 Campbell, Mrs E., 266, 280 Campbell Town (Australia), 228, 233, 237, 238 Campbell, W.W., 175, 246-249, 251-254, 258, 263-266, 280 Camptonville (California, USA), 262, 266, 316-317.322 Canada, 262, 264, 265, 290-296, 348, 358, 363, 367, 424, 618-620 Cancer, 123, 130, 131 Cape of Good Hope (South Africa), 236 Carcel standard lamp, 269, 273 Carnegie Institute of Washington (USA), 620 Carpenter, M.S., 416 Carter, A.W.L., 387, 468, 556, 596 Carter Observatory (New Zealand), 387, 556

Cartwright (Canada), 262, 264, 290-291 Carvings, 95, 96, 99, 100, 104, 107, 108 Cavendish Laboratory (England), 592, 603 Caves, 85, 87, 90, 91, 101, 104, 107, 117.904 Cavenne (French Guiana), 262, 263, 271-274 Celestial globe, 122, 123, 126, 130-132 Celestial mechanics, 172, 175-179, 182, 190, 193-194 Centaurus A, 405, 408, 410, 411 Central Library of Seoul National University (South Korea), 211 Cepheid variables, 190 Ceques, 86 Ceremonial doorway, 92, 100, 104, 107, 109, 116 Ceremonies, 73, 105, 107, 108, 111, 112 Cerro Unoraqui (Peru), 114, 115, 117 Chabot Observatory (USA), 254, 263, 266, 267, 279, 305 Chamberlin, T.C., 188 Chang'an (China), 12, 14, 143–145 Charged particles, 509, 607, 608 Chart recorder, 442–444, 446 Chatham Islands (New Zealand), 228, 233, 236-238 cheng, 13 Cheong Inji, 210 Cheonsang Yeolcha Bunya-jido, 199-207 chicha, 87-90, 93, 100 Chikhachev, B.M., 424, 618, 619 Chillas (Kaskmir), 67, 68 Chinchero (Peru), 86-89, 91 Chinese astronomical records, 225 Chinese characters, 53, 140, 147, 156, 202, 204 Chinese mathematics, 539 Chōkei Senmyō-reki Sanpō, 154, 156, 159 Choquequirao (Peru), 89 chou, 13 Chris-Cross Radio Telescope (Australia), 565, 577, 623 Christiansen, W.N. ('Chris'), 380, 381, 389-391, 393-403, 411-413, 416, 422, 423, 435, 456, 481, 483, 484, 547-583, 589, 600, 602, 605, 609, 614, 616, 619, 620, 623 Chromosphere, 253, 256, 258–259, 268, 271, 283, 285, 317-319, 321, 324, 325, 328, 330, 331, 348, 395, 397, 400, 570, 575, 617 Chromospheric plages, 616 Chronograph, 285, 303, 305, 331, 350 Chronometers, 230, 296, 322, 352 Chunqiu, 21-42 Chungiu Era, 21-42 Chuquimarca (Peru), 102

- Clark, A., 227, 231, 251, 253, 267, 268,
 - 270–273, 275–279, 350, 360
- Clark refractor, 267, 271–273, 276–279
- Classical astronomy, 172, 190, 192
- Clerke, A.M., 244, 258–260, 329, 340, 341, 355
- Climatic variations, 5, 19
- Cloud Physics, 434, 436, 474, 605
- Coal Sack, 462
- Coelostat, 251, 298, 317, 321, 328
- Collaroy (Australia), 549, 595, 617
- Comets, 54–56, 62, 65, 69, 140, 142, 147–148, 179, 190, 193, 210, 211, 219, 259
- Compound interferometer, 620
- Computers, 447, 571, 572, 605
- Condors, 104
- Congruence expressions, 163-168
- Conjunctions of the Moon with planets, 210, 211
- Constellations, 15, 65, 67, 69, 70, 74, 81,
- 123–125, 130, 132, 134, 136, 137, 147, 202, 203, 205, 219
- Continuum emission, 410, 577
- Contributions from the Lick Observatory, 326 Cook, J., 122, 302
- Cordillo Downs (Australia), 311
- Coricancha (Peru), 86, 90, 91, 94, 95, 116
- Corichancha (Peru), 88, 112
- Cornell University (USA), 416, 561
- Corona, 123, 124, 244, 245, 248, 250, 251, 254, 256–260, 268–273, 275, 276, 278, 283, 285, 286–289, 291, 293, 294, 296, 299–303, 305–308, 312, 313, 315–321, 323, 324, 326–332, 339–342, 345–348, 354, 357, 359, 362, 363, 365–368, 370, 384, 385, 390–392, 395, 397, 424, 457, 482, 487, 489, 502-505, 515–521, 531, 532, 535, 536, 539, 556, 570, 573, 575, 581, 594, 595, 597, 600, 606–613, 615, 616, 618, 619
- Coronagraph, 260, 538, 595, 615
- Coronal bright lines, 289, 301, 312
- Coronal brightness, 257–258, 283, 294, 327–328
- Coronal green line ('coronium'), 286, 291, 294, 300, 301, 303, 306–308, 317, 320, 328
- Coronal mass ejection events, 509
- Coronal motion, 257
- Coronal polarization, 254, 258, 289
- Coronal rays, 323, 342
- Coronal streamers, 283, 285, 286, 300, 307, 308
- Coronal studies, 273, 311, 340
- Cosh, J., 266, 318
- Cosmic rays, 500, 531, 604
- Cosmogony, 66, 67, 73, 74
- Cosmology, 71, 72, 87

- Covington, A.E., 424, 556, 618-620
- Crab Nebula, 54, 405, 408, 619
- Crimea (Russia), 619
- Crocker, C.F., 250, 261, 271, 278, 280, 286
- Crocker Telescope, 250
- Crocker, W.H., 265, 286, 290, 297, 305, 316
- Crossed-grating interferometer, 577, 581
- Crozet Island (Indian Ocean), 228, 237
- CSIRAC (CSIR Automatic Computer), 572, 574
- CSIRO Division of Physics (Australia), 500
- CSIRO Division of Radiophysics (Australia), 523, 540, 547, 589, 595
- Culgoora Radioheliograph (Australia), 425, 523, 534, 536, 538, 539, 603, 606, 617
- Curlewis, 311
- Curmey, M., 263, 278
- Cusco (Peru), 86, 89, 91, 92, 94, 95, 100, 102, 112, 114, 116
- Cygnus A, 402–404, 408, 424, 494, 495, 501, 600
- Cygnus X, 404, 408, 424

D

- Dakar (Africa), 619
- Dallmeyer camera, 271–273, 277, 278, 287, 289, 292
- Dapto Field Station (Australia), 481-523
- Dapto polarimeter, 495-497
- Darkroom, 276, 285, 311, 319, 323
- Davies, R.D., 390, 399, 400, 424, 456, 458, 557, 575
- dayan-qiuyi-shu, 165
- Day time hours, 150
- Delisle, J.-N., 226
- Δ*T*, 4–6, 8–19, 22, 23, 27–29, 31–42, 141, 145, 146
- Department of Terrestrial Magnetism (USA), 441, 456, 457, 620
- Descending node, 79, 157, 158, 163
- Design, 75, 76, 91, 204, 245, 247, 248, 282, 326, 383, 396, 408, 414, 422, 434–438, 441, 468, 527, 536, 547, 548, 556, 557,
 - 570, 577, 591, 595–603, 605, 609
- Deslandres' theory of the corona, 283
- Deuterium line, 435, 437, 441, 562
- De Vaucouleurs, G., 415, 470, 472
- Developmental phases in astronomy, 67
- de Voogt, A.H., 618
- Dicke, R.H., 406, 617
- Differential galactic rotation, 456, 458
- Diffraction bands, 268
- Diffraction grating, 554

Index

Digital recording and data reduction system, 445, 468 Digital shaft encoder, 448 Discrete sources, 402-405, 407, 410, 424, 483, 582, 605 Distance estimates, 458 Divination, 100, 154 Division of Radiophysics, CSIRO (Australia), 379-523, 527, 535, 536, 540, 543-545, 547, 548, 580, 581, 589, 590, 594, 595, 604-606, 608, 616 Dodson, H.W., 400, 423, 575 Do Jeung, 200 Double lobe sources, 410 Double stars, 247, 272 Dover Heights Field Station (Australia), 434, 435, 483, 594, 598 Dragons, 47-50, 52 Dust clouds, 454

Е

Eaglehawk Neck (Australia), 394, 553 Earth, 3-19, 22, 28, 42, 62, 63, 67, 72, 74, 78, 86-89, 96, 104, 141, 147, 226, 277, 294, 297, 301, 316, 340, 348, 361, 366, 367, 380, 383, 399, 421, 422, 443, 450, 470, 472, 509, 512, 531, 534, 536, 570, 576, 581, 595, 597, 600, 607, 613 Earth-Moon system, 4 Earthquakes, 141 Earth rotational synthesis, 380, 399, 422, 570, 576, 581 Earth's rotation, 3-19, 22, 78, 383, 421, 422, 450, 570, 597 East-west problem of latitude observations, 182 East-West Solar Grating Array, 422, 557-561, 565 Eclipse Committee of the American Astronomical Society, 314 Eclipse expeditions, 192, 243-332, 349, 357, 358, 360 Ecliptic, 69, 107, 124, 127, 129, 268, 341 Eddington, Sir Arthur, 190, 261, 328, 329 Edison, T., 260, 357, 365-367, 370 Edlén, B., 328 Edmondson, F.K., 416 Edo Period (Japan), 155, 168 Einstein's General Theory of Relativity, 261, 302, 303, 328-329 Electrical workshop, 604 Electron density, 487, 505, 515, 532, 556 Electronics, 592 Electron temperature, 410

Elgaroy, O., 621 Elgin watches, 296 Emission, 259, 260, 312, 316, 317, 320, 321, 331, 380, 388, 390, 400-403, 408, 410-415, 420, 424, 425, 433, 435, 454, 458, 461, 462, 464, 467, 470, 471, 482, 487, 501, 504, 506, 509, 514, 517-519, 531, 534, 539, 543-545, 556, 560, 561, 564-566, 568, 575, 577, 580-582, 592, 593, 595, 598, 604, 607-611, 613, 616-618, 621 Emission lines, 259, 260, 320, 321, 545 Emission nebulae, 410, 415, 582 Engineers, 238, 263, 380, 421, 590 Ensenada, Baja California (Mexico), 262, 265, 314-316 Eos asteroid family, 174, 175, 181 Equatorial mounting, 252, 276, 312 Equinoxes, 64, 65, 70, 76, 99, 101 Equipment hut, 420, 438, 440, 443 Erickson, W.C. ('Bill'), 455-457 Eruptive prominences, 317, 321, 504, 536, 538 Eta Carinae Nebula, 410 Ethnoastronomy, 116 Europe, 5, 13, 16, 54, 75, 295, 302, 359, 360, 364 Ewen, H.I., 402, 412, 543, 545, 561-563 Extinction, 454

Extra-galactic research, 424, 474

F

Fabry and Perot etalon interferometer spectrograph, 320 Faculae, 256 Fairweather, G., 420, 596 Fan beams, 395, 396, 559, 577, 600 'Father Sky', 63 FIAN (Russia), 619 Filter banks, 600 Firor, J.W., 620 Flare patrol telescope, 500 Flares, 500-501, 504 Flash spectrum, 251, 252, 258, 292, 301, 303, 308, 317, 321 Fleet, Captain, 263, 283 Fleurs Field Station (Australia), 401, 577-581 Fleurs Synthesis Telescope (Australia), 582, 583 Flint Island (Pacific Ocean), 251, 262, 265, 297-302, 326 Flora asteroid family, 175 Florence (Italy), 283 Floyd Telescope, 251, 287, 303, 317

Fokker, A.D., 620-622 Folded dipoles, 407 Folk astronomy, 121, 137 Ford Foundation, 481, 534, 589, 603, 606 Fort Davis Field Station (USA), 620 Fountains, 94, 117 Fourier analysis, 398, 422, 554, 570, 571, 573 France, 129, 226, 227, 311, 332, 399, 422, 423, 506, 576, 615, 618, 620, 621, 623 Franklin, K.L., 355, 390, 420 Fraunhofer lines, 288, 289, 294, 312 Frequency, 218, 371, 382, 387, 390, 394, 403, 407, 411, 412, 414, 415, 422-424, 434, 435, 438, 441-445, 458, 482, 484-487, 489-493, 495-497, 499, 501-503, 506, 507, 509-515, 518, 521-523, 527, 529-533, 544, 545, 551, 554, 556, 558, 559, 564, 569, 591, 592, 598, 600, 604, 609-611, 613-615, 617, 621-623 Frogs. 88 Fryeburg (Maine), 318-321 Fujiwara Matsusaburz, 165 Fukuoka (Japan), 150 Funding, 233, 235, 244, 261, 271, 278, 290, 297, 316, 326, 327, 331, 534, 580, 591, 603-606

G

Galactic Centre, 405, 408, 417, 424, 435, 455, 456, 467, 468 Galactic equator, 412, 455, 457, 466, 564 Galactic poles, 455 Galactic research, 424 Galactic rotation, 416, 454-456, 458, 463 Galactic structure, 412, 415, 416 Galaxies, 136, 245, 246, 380, 403, 406, 408, 410, 412, 414–420, 423, 424, 433, 435, 442, 454, 458, 462, 463, 467, 470, 472, 564, 581, 582, 603 Gale, W.F., 263, 277, 278, 291 y-ray, 613 ganzhi, 22, 23, 26, 42, 160 Gardner, F.F., 420, 421 Gascoigne, Ben, 539 Gas flow, 409 Gelfreich, G.B., 621 geng, 13 Geodetic measurements, 264, 316 Geomagnetic disturbances, 621 Geonsang Yeolcha Bunya-ji-Do, 199

Geophysics, 22, 193 Georges Heights Field Station (Australia), 550-551 Germany, 129, 176, 226, 369 Getmanzev, G.G., 435 Ginat, M., 619 Ginzburg, V.L., 515, 606, 618 Giovanelli, R.G., 504 Glancy, E., 265, 308 Gnomon, 95, 104, 105 gods, 49, 62, 63, 67, 71, 72, 80, 87 Goldendale (Washington State, USA), 262, 265, 304-308 Gongyang-zhuan, 22-26, 40, 41 Gorky State University (Russia), 435 Gorveosa Cheolyo, 211 Goth Hill (Canada), 619, 620 Grazing occultation, 145 Great Comet of 1901, 290 Great Rift, 462 Greek astronomy, 78 Green Bank (USA), 436 Greenstein, J.L., 454, 544, 604 Grotrian, 328 Guliang-zhuan, 22, 23, 25, 26, 41 Gum, C.S., 408, 410, 418-420, 452 Gun-laying radar trailer, 438 Guo Shoujing, 155

H

Hachijo-jima (Japan), 621 Haddock, F., 506, 513, 620 Hagen, J.P., 424, 619 Hagihara Yusuke, 176, 188 Hale, G..E., 329, 332, 392, 540 Halley, E., 226, 235 Halley's Comet, 218-221 Hanbury-Brown, Robert, 380, 406, 422, 597 Han Dynasty (China), 22, 23 Hanshu, 12, 23, 26, 41, 147 Harkness, W., 233, 237, 257, 260, 354, 355, 358, 360, 365 Harmonic structure, 482, 486, 487, 504, 532, 611, 619 Harvard College Observatory (USA), 229, 253, 266, 278, 327, 328, 350, 357, 371, 561 Harvard University (USA), 358, 543, 561, 620 Hastings, C.S., 254, 258, 267, 268 Hazama Shigetomi, 155 Hazard, C., 406 Hearst, Mrs Phoebe, 262, 274, 279, 302

Index

Heat-sink, 443 Hecuba, 188 Hefner standard lamp, 299, 300, 315 Height versus time plots, 611 Heinrich Hertz Institute (Berlin), 622 Heliostat, 229, 230 Helium, 259, 348 Helium line, 259, 348 Hellerich, J., 190 Helwan Observatory (Egypt), 295 Hepburn, N., 154, 159, 160, 619 Hercules A, 405 Heritage, 583 'Herringbone' structure, 506, 516-521 Herschel, J., 236, 259, 260, 340, 540 Herschel, L., 348 Hey, J.S., 402, 435, 605, 617, 618 HI clouds, 464 Higgins, C.S., 421 Higgs, A., 562 High resolution, 244, 276, 299, 391, 395, 406, 422, 473, 554, 565, 600 HII regions, 408, 410, 451, 452, 462, 471 Hilda, 188 Hilda asteroid group, 180 Hill, C.B., 263, 267, 268, 283 Hindman, J. Hiravama Akira, 166 Hirayama Kiyotsugu, 171-194 Hiroi, 279 Historians of astronomy, 19, 213 History Science Society of Japan, 191 H-line multi-channel receiver, 435 H-line profiles, 416, 446, 455, 458, 463, 466, 472 Hobart (Australia), 228, 232, 233, 237, 238 Holden, E.S., 244, 245, 250, 258, 260, 261, 266, 267, 269-274, 277, 279, 280, 306, 323, 326, 327-329, 358, 365, 367 Hole, A., 263, 277 'hole-in-the-ground' aerial, 435 Holland, 227, 264, 512, 563, 623 Holmes, E.C.J., 468 Horizon markers, 116 Horizontal heliograph, 248 Hornsby Valley Field Station (Australia), 380, 390, 420, 618 Hosking, J.B.O., 265, 309 Houhanshu, 12, 147 Houtgast, J., 618 Howard Clock Company, 230 huacas, 85-117 Huayna Capac, 86, 91, 109, 112, 115, 116

Hubble's zone of avoidance, 454 Hudson Bay Company, 290 Hulst, H.C. van de, 402, 416, 463, 464, 467, 543, 556, 561 Humans, 62, 63, 72, 88, 361 Hunter-gatherer societies, 66 Hussey, W.J., 265, 282, 295, 296 Hwando, 46, 47 Hydrogen, 259, 260, 331, 348, 354, 359, 367, 369, 380, 402, 408, 412–417, 419, 423, 424, 433, 436, 442, 448, 451, 453–467, 469–472, 475, 543–545, 564–566, 582, 598

Hydrogen-line emission, 412, 413, 566

I

idai-keishō, 155, 156 Ikeda Masaoki, 156 Ikhsanova, V., 621 Incas, 85, 87, 89, 91, 94, 96, 104, 105, 108, 109, 111, 114 India, 62, 70, 74, 75, 80-82, 129, 130, 235, 251, 262, 263, 279-283, 285, 286, 345, 346, 348, 359, 362, 387, 401, 491, 557, 620 Indian astronomy, 65 Indian culture, 70 Indian Ocean, 227, 228, 233, 236, 239 Indian prehistory, 61 Indian temples, 75 Indus culture, 75-76 Innovative design, 591, 595-602 Instrumentation, 78, 229-232, 234, 243, 421 Intercalary months, 70, 71, 79, 159 Interference fringes, 403, 500, 555, 556, 595 Interference pattern, 383, 387, 406, 421, 492, 493, 511, 550, 596, 597 International Astronomical Union, 233, 247, 540 International Astronomy Union (IAU) sub-commission 33b, 418 International Geophysical Year, 621 Interplanetary shock waves, 615 Interscan, 536 "In the Shadow of the Moon" (diary), 280 Intimachay (Peru), 91 Intiwatana (Peru), 89, 90, 94–96, 117 Intra-Mercurial cameras, 253 Intra-Mercurial planets, 299, 303, 313, 350, 352 Ionised gas, 404 Ionosphere, 402, 403, 420, 421, 493, 494, 518, 523, 534, 592, 612, 613, 618 Ionospheric research, 590 Iran, 122, 123, 129

Isfahan, 122 Isophote maps, 57, 580, 581, 616 Italy, 129, 227, 295, 341

J

Jaeger, J.C., 502, 504, 515 Jōkyō-reki, 155, 159 Jansky, K., 592, 603 Janssen, J., 227, 258 Jantar Mantars, 80 Japan, 54-56, 140-151, 154-156, 159, 164, 165, 168, 172, 176, 177, 179, 185-188, 190-193, 200, 227, 233, 262, 263, 278-280, 422, 619, 621, 623 Japanese astronomical records, 140 Japanese astronomy, 139-151, 154-155, 176, 182, 188, 192 Japan-Russia Border, 185-188 Jeffers, J.M., 317 Jeur (India), 262, 263, 279-283 Ji-an. 46–52 Jiankang (China), 15 Jinkōki, 155, 156 Jitô era, 140, 141, 148-149, 151 Jodrell Bank, 400, 416, 422, 424, 435, 436, 441, 456, 575, 597 Joisce, J., 491 Jomei era, 140, 142, 144, 147 Joseon Dynasty (Korea), 201, 203, 211, 214 Joseon Wangjo Sillok, 211, 212, 215, 216 Jovian bursts, 420-421

Jupiter, 80, 148–149, 174, 179–181, 188, 367, 382, 390, 420, 421

K

Kakinuma, T., 619, 621 Kalyan Radio Telescope (India), 401 Kansei-reki, 155 Karnataka (India), 63, 64 Kaya, 45, 46 ke, 13, 16 Keeler, J.E., 245, 246, 263, 267-270, 284, 286, 329 Keeling, B.F.E., 295 keisaku, 157, 159, 161-162 Kengyōsō, 156, 159 Kenki-sanpō, 153-168 Kenki-sanpō dai-shijūku kaijutsu, 158 Kenko Grande (Peru), 88, 95–102 Kennedy Dish (Australia), 437 Kensington (England), 283 Keonsang Yeolcha Bunya-ji-Do, 204, 205, 207 Kerguelen Island (Indian Ocean), 228, 233, 236.237 Kerr, F., 380, 405, 412, 414-419, 434-436, 441, 463, 464, 467, 469, 471, 472, 548, 550, 561, 562, 565, 598, 605 Khaykin, S.E., 424, 618 Kim Cheongso, 210, 211 Kimura Hisashi, 172, 176 King Gojong, 215 King Gongmin, 204 King Injo, 216 King, J., 263, 278 King Taejo, 201 King Taejong, 211, 214 King Yangweon, 52 King Yi Taijo, 207 Kirchhoff, G.R., 259 Kirkwood gaps, 178-181, 188, 189 Kodaikanal Observatory (India), 387, 557 Koguryo Tumulus, 45-52 Komesaroff, M., 491 Kootwijk (The Netherlands), 441, 620 Korea, 46, 54, 55, 143, 144, 146-148, 154, 156, 159, 190-193, 199-207, 210, 215 Korean astronomical records, 209-221 Korean National Treasure, 203 Koronis asteroid family, 174, 175, 181 Koryo Dynasty (Korea), 204, 206 Koryo-sa, 159, 204 Koryo star chart, 206, 207 Krishnan, T., 401, 402, 580 Kundu, M., 620 Kwan Reuk, 200 Kwon Keun, 201, 203-207

L

Labrum, N., 387, 393, 401, 402, 536, 580, 617,618 Lacco (Peru), 87, 90, 102-108, 117 Laffineur, M., 618 Lake Titicaca (Peru), 87, 88, 101 Large Magellanic Cloud, 407, 415, 422, 471, 473 Latitude, 13, 16, 29-31, 73, 78, 108, 129, 172, 176, 178, 182–186, 193, 218, 226, 231, 262, 272, 299, 311, 316, 322, 416, 418, 450, 455-460, 462, 463, 573, 607, 613 Latitude observations, 178, 182-186, 193 Latitude variation, 172, 176, 184-186, 193 Le Gentil de la Galasiere, 235 Le Grande Interferometer (France), 425, 620, 621 Lehany, F., 381, 548, 550, 618, 619

Leiden, 264, 412, 416-419, 423, 463 Leiden-Sydney H-line map, 423 Leuschner, A.O., 263, 267, 268, 305 Library, 129, 178, 209, 216, 604 Lick, J., 244, 251, 261, 331 Lick Observatory, 243-332, 357, 371 Lick Observatory Board of Regents, 244, 245, 273 Lick Observatory Bulletin, 326 Lick Observatory Leaflets, 326 Light-tube, 107, 108, 117 Limb-brightening, 391, 392, 395, 399, 401, 402, 422, 548, 550-556, 561, 568, 569, 573, 575, 576, 581, 610, 619, 620 Little, A., 380, 384-388, 390, 391, 407, 421-423, 513, 514, 551, 595-597, 600, 602, 613, 615, 619 Little, C.G., 402 'Little Science,' 590 Liuxin, 22, 24–26 Llactapata (Peru), 88, 90-95, 116, 117 Llamas, 88, 108 Lloyd's mirror, 595 Local oscillator, 383, 436, 438, 440, 443, 445 Lockyer, N., 258-260 Long-baseline interferometry, 597 Longitude, 29, 31, 78, 123, 127, 129, 157, 174, 203, 226, 231, 233, 262, 272, 299, 311, 316, 322, 416, 418, 450, 456–462, 613 Loughhead, R.E., 500, 501 Lovell, B., 402 Luck, 237, 563, 590, 591, 594 Lumsden, G.E., 264, 285 Lunar eclipse, 4-6, 8-14, 16, 22, 23, 27, 142-144, 148, 211, 367 Lunar laser ranging, 4 Lunar observations, 6, 8, 617 Lunar occultation of Mars. 140, 145-146 Lunar occultations, 4, 140, 142-146 Lunar tidal acceleration (LTA), 22, 28, 29, 31, 32, 35-38, 42 Luni-solar calendar, 76, 159-160 Luoyang (China), 12 Lvons, Captain H.G., 295 Lyot, B., 260, 331, 332, 554, 555, 600

M

MacAlister, K., 494, 604 Macgregory, W., 290 Machin, K.E., 391 Machu Picchu (Peru), 87, 89–95, 116, 117 Madrid Observatory (Spain), 291 Magazines, 319, 359 Magellanic stream, 470, 472 Magnetic crochets, 390 Magnetic fields, 332, 392, 400, 458, 487, 506, 509, 518, 519, 536, 551, 552, 575, 604, 613 Magnetogram, 387, 557 Magneto-hydrodynamic shock waves, 519 Magnitudes, 15, 28, 37, 69, 121, 122, 124-126, 129, 130, 133-136, 138, 142, 144, 145, 184, 226, 247, 254, 260, 289, 350, 403, 505, 512, 517 Mahabharata, 73, 74 Makala (Africa), 619 Malvern (England), 423, 435 Manuscripts, 22, 52, 87, 122, 125, 126, 129-130, 132, 159, 166, 167, 193, 326, 590 Mare Island (USA), 315, 317 Maria asteroid family, 175 Mars, 9, 140, 142, 145-146, 148-149, 218, 219, 367 Martyn, D.F., 391, 548, 592, 593, 606, 607, 609, 611, 618 Mathematical astronomy, 74, 79, 154, 168 Mathematical texts, 153–168 Mathematics, 62, 76, 79, 154-156, 165, 166, 177, 194, 323, 539 Mathewson, D., 401, 423, 437, 438, 461, 470, 472, 481, 577, 580, 583, 589, 602, 616, 620 Maxwell, A., 513, 620 McCready, L., 382, 421, 436-438, 482-484, 490, 527, 529, 530, 548, 555, 593-595, 598, 607-610, 618, 619 McGee, R., 382, 405, 435, 437, 438, 440, 442, 447, 450-468, 618 McLean, D., 506-510, 617 McMath Hulbert Observatory (USA), 401 Mechanical workshop, 604 Medical imaging, 572 Megalithic Period, 70 Megaliths, 69, 75 Melbourne (Australia), 227, 237, 309, 315, 390, 391, 548, 603 Menzel, D.H., 252, 253, 266, 317, 320, 324, 328, 330, 331, 561 Mercury, 65, 149, 260, 268, 302, 367 Merfield, C.J., 265, 301, 315 Merfield, Z.A., 265, 315, 316 Meteorite fall, 142, 144 Meteoroids, 189 Meteorological reports, 266, 278, 280, 314, 318, 350, 352, 360, 362, 363

- Meteors, 54–57, 62, 65, 140–142, 147, 148, 210, 211, 259, 352, 362 Meteor showers, 62
- Meudon Observatory (France), 399, 422, 576, 618
- Mexico, 227, 262, 265, 314-316, 368
- Michelson interferometer, 383, 391, 402, 403, 422, 548, 554
- Micrometer, 184, 185, 231
- Milan (Italy), 283
- Milky Way, 88, 94, 250, 323, 412, 415, 416, 420, 458, 463, 592
- Miller, J.A., 264, 285, 324, 329
- Mills, B., 385, 391, 400, 402, 403, 406, 407, 410, 422, 424, 494, 539, 544, 547, 551, 576, 602, 605
- Mills Cross, 411, 420, 422, 434, 539, 577, 578, 605
- Mills Cross prototype, 382, 406–407, 422, 576, 602
- Milton, J.A., 455-456, 462, 463, 466-468
- Mina Bronces (Chile), 262, 263, 274–278
- Minkowski Rudolf, 403
- Minnett, H., 387, 393, 402–406, 408, 424, 490, 548, 553, 571, 618
- Missing mass, 472
- Mitaka (Japan), 621
- Mixer, 440
- Mizusawa Latitude Observatory (Japan), 176
- Mohenjo Daro, 75, 76
- Monthly Notices of the Royal Astronomical Society, 176, 266, 331
- Moon, 3, 4, 6, 8, 16, 22, 26, 30, 47, 49, 50, 63–65, 69, 70, 73, 74, 79–81, 87, 102, 107, 108, 142, 145, 146, 148, 157–163, 178, 179, 190, 193, 194, 202, 203, 210–212, 218, 219, 249, 256–259, 268, 269, 273, 280, 294, 297, 299–301, 311, 340, 341, 345, 359, 367, 369, 391, 392, 405, 552 Moore, J.H., 265, 266, 306, 307, 312,
- 316–318, 320 316–318, 320
- Moray, 91
- Morgan, W.W., 305, 412, 564
- Morioka (Japan), 150
- Mortimer, 265, 300
- Moscow, 418
- 'Mother Earth,' 63
- Moulton, F.R., 189
- Mountains, 13, 85, 87
- Mt. Stromlo Observatory, 387, 389, 390, 400, 415, 556, 575, 594, 607, 618
- Mt Wilson Observatory, 329, 332, 403, 592
- Mullaly, R., 580, 616

- Muller, C.A., 412, 450, 463, 543, 561, 563
- Multi-channel H-line receiver, 435
- Multi-frequency observations, 614
- Multi-phase interferometer, 621
- Mummies, 87, 88, 96, 101, 112 *Munheon Bigo*, 212
- Murals, 45–52
- Murraybank Field Station (Australia), 433-475
- Murray, J., 434–438, 442, 443, 446, 447, 450–461, 468, 470, 474, 483–487, 489,
- 491, 493, 495, 527, 529, 532, 544
- Museums, 6, 7, 129, 187, 203, 206, 236, 238
- Myths, 62–64, 69, 78, 87, 88

Ν

- Nagasaki (Japan), 233
- Nakayama, S., 156, 176
- Nakshtras (Indian lunar mansions), 69
- Nançay (France), 506, 620, 621
- Nara (Japan), 150
- NASA, 425, 475, 613
- National Observatory, Poulkowa, 304
- National Palace Museum (Seoul), 203
- National Radio Astronomy Observatory (USA), 605
- Natural landscape, 85
- Nature, 5, 62, 63, 67, 72, 73, 87–89, 91, 176, 178, 239, 245, 247, 256–261, 271, 330, 339, 340, 348, 349, 359, 364, 365, 369, 401, 405, 406, 410, 411, 416, 454, 456, 458, 482, 493, 518, 532, 543, 552, 553,
 - 556, 563, 572, 577, 598, 607, 609
- Nautical Almanac Office, 233, 316, 322, 355, 364
- Navigational astronomy, 81
- Nazca (Peru), 86
- Nebulae, 136-137
- Needham, J., 6, 156, 191
- Negatives, 4, 6, 257, 269, 272, 273, 278, 286–289, 294, 296, 301, 302, 313, 341, 343, 435, 455, 462, 521
- NERA (The Netherlands), 620-622
- Netherlands, 410, 441, 456, 468, 618, 620–622
- Neutral hydrogen (HI), 415, 417–419, 423, 424, 433, 435, 451–464, 467–472, 475, 582
- Newcomb, S., 186, 228–230, 233, 257, 357, 360, 365
- New Moon, 65, 80, 157, 159–163
- Newspapers, 234, 236, 237, 239, 323, 340, 350, 360, 362–364, 366–368, 370, 484
- New York Times, 225-239, 339-371

New Zealand, 227, 233, 235-239, 265, 298, 309, 387, 438, 439, 556, 617 Neylan, A.A, 518 NGC 7293 (Helix Nebula), 405 Nice (France), 283 Nihon-Buntoku-Tennô-Jitsuroku, 140 Nihongi, 140-151 Nihon-Kirvaku, 140 Nihon-Kôki, 140 Nihon-Sandai-Jitsuroku, 140 Nihon-shoki, 154 Non-thermal emission, 454, 604 Nova. 142 N-S Solar Grating Array, 422 Nyūk!plainhan, 163 Nvūreki-shintai, 162

0

Objective lens, 276, 281, 319 O'Brien, P.A., 391, 399, 422, 556, 619 Observatories, 80, 244, 253, 284, 295, 322, 349, 616, 621, 622 Observing frequencies, 594, 609 Oda, M., 619 Ohlston, J., 438 Oh Yoonbu, 204 Ollantaytambo (Peru), 87, 89-91 Olsen, B., 266, 318 Onake Kindi Hill, 63, 64 Ondrejev Astronomical Observatory (Czechoslovakia), 622 Onmō!-ryō, 154 Oort, J.H., 136, 412, 415, 416, 418, 419, 423 Oort's constant, 458 **Ophiuchus Complex**, 462 Optical astronomers, 604 Orbiting telescopes, 595 Oriental astronomical records, 53–57 Orion, 69, 124, 417, 418, 452-454, 462,466 Orion Arm, 417, 418 Orion Nebula Cluster, 454 Orion-Taurus-Perseus region, 462 Osaka University (Japan), 619 Osterbrock, D.E, 244-246, 261, 326, 332 Owren, L., 561 Oxford, 129, 130, 138, 283, 295

Р

Pachacuti, 86, 87, 91 Pachamama (Peru), 89, 91 Pacific, 176, 247, 262, 264-266, 280, 323, 326, 350, 361, 363, 364 Padang (Sumatra), 262, 264, 286–290 Paekche Kingdom (Korea), 45, 46, 144, 147, 154 Pallas asteroid family, 175 Paraboloid, 381, 382, 391, 392, 403-405, 408, 412, 435, 436, 444, 563 Parallax, 226, 233, 454 Paris (France), 129, 138 Paris Observatory (France), 368, 620 Parkes Radio Telescope (Australia), 425 Paros (Aegean Sea), 33 Parsons, S.J., 402 Parthasarathy, R., 399, 400, 575, 576, 620 Parties, 227-229, 234-237, 239, 266, 284, 286, 296, 298, 324, 355-358, 360, 363-365, 367, 371, 539, 540 Pasteur, L., 591 Paul Wild Observatory (Australia), 539 Pawsey, J.L, 380, 391, 400, 402, 407, 408, 412, 414, 418-420, 434-437, 482-484, 490, 529, 530, 543, 544, 547, 555-557, 561-564, 571, 575, 590, 591, 593, 594, 596, 598, 601, 603-606, 617, 618 Payne-Scott, R., 380-388, 390, 399, 421, 423, 425, 497, 502, 513, 514, 530, 531, 544, 551, 555, 593, -597, 600, 607, 608, 613, 615, 618, 619 Peking (China), 233 Pencil-beam instrument, 408 Penrith Field Station (Australia), 391, 482, 529, 598, 611 Perigee, 155, 157, 158, 162 Perrine, C.D., 261, 264, 265, 284-287, 289-292, 295, 296, 299, 301, 308, 322 Perseus Arm, 417 Perth Observatory (Australia), 309, 311 Peru, 95 Petzval lens, 250 Phase switched interferometer, 406, 422 Phillips, J.W., 402 Phocaea asteroid family, 175 Photographic Association of the Pacific Coast, 266.323 Photographic moving plate holder, 229, 230 Photographic telescope, 229, 231, 232, 279.285 Photography, 229, 244, 250, 257, 268, 283, 285, 291, 299, 302, 303, 306, 319, 323, 331, 339-341, 346, 361, 366, 370 Photoheliograph, 229-231, 277, 341 Photometers, 254-256, 268, 294, 352 Photosphere, 258, 271, 288, 292, 400, 534, 575,616

- Physicists, 177, 185, 245, 247, 330, 365, 539, 547, 590
- Pickering, E.C., 327, 328
- Pickering, W.H., 258, 269, 357, 358
- Pick, M., 620
- Piddington, J.H., 390, 393, 394, 400, 402–406, 408–410, 420, 424, 548, 551, 553, 562, 575, 618
- Pierson, W.N., 275, 279, 287, 289, 290
- Pillars, 62, 75, 85, 104, 109-117
- Pisac (Peru), 89-91, 104
- Planetary observations, 6, 8, 218
- Planetary orbits, 78, 79
- Planetesimal hypothesis, 188
- Planets, 3, 6, 54, 65, 69, 73, 78, 79, 140, 141, 148, 149, 160, 178, 179, 189, 190, 210, 211, 218, 243, 260, 291, 299, 302, 303, 306, 307, 313, 341, 350, 352, 354, 359, 363, 366–369, 371, 420
- Planisphere, 199-207
- Plasma hypothesis, 151, 482, 487, 532, 611, 621
- Plasma levels, 390, 482, 501–503, 506, 509, 514–516, 611
- Plasma oscillations, 519
- Plate-holder, 229, 230, 281, 282, 311
- Platforms, 87, 88, 95, 104, 105, 108, 109, 112–114, 117, 368, 370, 440
- Pleiades, 90, 92, 94, 116, 203
- Polarigraphs, 254–256, 288, 289, 291, 294, 298, 301, 308, 316
- Polarization studies, 254, 291, 300, 306, 357, 484
- Pondicherry (India), 235
- Portrait cameras, 250-251
- Positional astronomy, 172, 177, 182
- Post-glacial isostatic compensation, 4
- 'Post-hole Digger,' 557
- Potts Hill Field Station (Australia), 379–425, 551–577
- Power supplies, 436, 553
- Pre-amplifiers, 383, 440
- Precession, 65, 70, 75, 123, 127, 203
- Press releases, 323
- Pre-telescopic period, 3, 4, 22
- Price, R., 435
- Primary feed, 439, 440, 442
- Princeton University (USA), 129, 264, 282
- Private collectors, 203
- Proceedings of the Royal Society, 593
- Proctor, R., 226, 227, 234, 239, 244, 257–260, 340, 341, 343, 345, 369, 370

- Prominences, 256, 259, 283, 285–287, 289, 291, 294–296, 300, 308, 312, 317, 319–321, 341, 346–348, 350, 352, 354, 357, 359, 362, 364, 393, 504, 536, 538, 553, 609
 Proper motions, 178
 Pteria (Asia Minor), 31, 35, 36
 Ptolemy, 6, 122, 123, 126, 127, 130, 133–137
 Public lectures, 239, 371
 Pumas, 88, 96–100, 104, 107
 Puppis-Vela gas clouds, 466
 Purcell, E.M., 402, 412, 543, 561–563
 Puschino (Russia), 621
 Pyongyang (North Korea), 46, 199
- Pyxis-Hydra region, 450–452, 454

Q

- Qin Jiushao, 165
- Quarterly Bulletin of Solar Activity, 616, 621
- Quasars, 598 Ouechua, 86–88, 100, 109
- Queenstown (New Zealand), 233, 237
- Queenstown (196w Zealand), 253, 257 Quespiwanka (Peru), 89, 90, 109–114
- Oufu (China), 27–29, 31–38, 40, 42
- Quiet Sun, 391–402, 423, 481, 556, 575, 576, 580, 589, 600, 609, 610, 617–620

R

- Radar, 233, 381, 391, 408, 423, 438, 439, 484, 527, 540, 548, 549, 582, 590–592, 594, 595, 603, 605, 617
- Radar aerial, 548, 549
- Radial velocity, 246, 418, 442, 445, 450, 452–456, 458, 461–464, 466, 469, 472, 517
- Radial velocity-distance model, 463
- Radio astronomy, 379–425, 433–475, 481–523, 535, 539, 540, 543, 545, 547–583, 589–623
- Radio astronomy field stations, 433
- Radio brightness distribution, 399, 555, 573, 577
- Radio-emitting regions, 607, 617
- Radio galaxies, 582
- Radioheliograph, 425, 481, 523, 534–536, 538, 539, 577, 589, 603, 606, 617
- Radio interference, 420, 425, 483
- Radiophysics Laboratory (Australia), 435, 436, 549, 551, 561, 574, 594, 598
- Radiophysics Solar Group (Australia), 482, 523, 535, 580, 623
- Radiophysics workshops (Australia), 438

Radio plages, 401, 580, 581, 616 Radio scintillations, 490-491, 590, 600 Radiospectrograph, 482-490, 514, 515, 518, 521-523, 527, 529, 531, 534, 598, 599, 604, 605, 609, 618-621 'Radio stars,' 438 Rain, 62, 63, 88, 94, 237, 269, 281, 287, 288, 300, 314, 317, 319, 348, 436, 605 Rain-making, 605 Rao, U.V. Gopala, 536 Ratcliffe, J., 603 Raymond, Captain, 237, 238 Rayy (Iran), 122 Réache, M.G., 271 Reber, G., 543, 544, 617 Receivers, 66, 420, 423, 441, 483-485, 487, 527, 594, 595 Recombination lines, 412, 545 Red-shift, 435 Reflecting telescopes, 271, 272, 274, 276, 346, 441 Refracting telescopes, 231, 244 Rekihou to Jihou, 191 Religion, 62, 63, 70, 75, 86 Reptiles, 88 Research Institute of Atmospherics, Nagoya University (Japan), 422 Resisting medium, 171, 188-190, 193 Resolution, 244, 268, 276, 299, 382, 391, 395, 402, 404, 406, 408, 419, 422, 454, 457, 469, 473, 554, 565, 577, 597, 598, 600, 621 Restoration, 172, 191, 211, 215, 216 Reverse drift pairs, 501-503 Reversing layer, 258, 283, 285, 292, 303, 306.317 Rhombic antennas, 512 Ridge-type scintillation, 493 *Rig Veda*, 69–71, 75, 76 Rikkokushi, 140 Rituals, 70, 86 Roberts, J., 529, 600 Robinson, B., 414, 434, 490, 623 Rock art, 64, 67-69 Rockbank (Australia), 391, 393, 551, 552 Rocks, 85, 86, 89, 91, 112 Rome (Italy), 283 Ross, A.D., 265, 309, 317 Rotating-lobe interferometer, 597 Rotation curves, 418 Rowe, B., 86, 484, 488, 491, 527-529, 532

Royal Astronomical Society, 176, 266, 280, 331, 345, 355, 356, 369, 540 Royal Astronomical Society's Eclipse Committee, 271 Royal Observatory, Cape of Good Hope (South Africa), 236 Royal Radar Establishment (England), 423 Royal Society (England), 226, 369, 540, 593 Rubbings, 201-203, 207 Rue, Warren De La, 244, 257, 341, 355 Rufus, W.C., 200, 203 Russell, H.N., 330, 331 Russia, 129, 185-188, 193, 233, 261, 262, 265, 302-305, 307, 613, 619, 621 Ryle, M., 402, 422, 554, 593, 597, 607, 618

S

Sacsahuaman (Peru), 95, 102 Sagittarius A, 382, 405-406, 408, 420, 424 Sagittarius Arm, 417 Saihuite (Peru), 86, 88, 90, 94 Sakhalin Island (Japan/Russia), 185-188 Salcantay (Peru), 104 Samguk Sagi, 49, 52, 210 Sanctuary of the Island of the Sun (Peru), 88.112 Sapporo (Japan), 279 Saptarshi calendar, 73, 74 Satellite communication, 613 Satellites, 4, 179, 188, 192, 613 Saturn, 149 Schaeberle 40-foot Eclipse Camera, 275, 323 Schaeberle, J.M., 245, 248, 249, 263, 272-276, 278-280, 323, 327, 329, 330 Schaeberles' Mechanical Theory of the Corona, 245, 323, 329 Schjellerup, H.K.F., 130 Schmidt, M., 416, 463 Schulkin, M., 619 Scientific results, 322, 490, 501, 606-617 Scintillations, 403, 420, 421, 491, 493, 495, 501 Scorpius-Ophiuchus region, 457 Scribal errors, 9, 14, 16, 130, 167 Scutum-Norma Arm, 417, 418 Sea-interferometry, 382, 421, 593-596, 607 Sea-level changes, 5 Seasickness, 280 Seasons, 13, 64, 66-68, 70, 78, 79, 159, 203 Secchi, Fr Angelo, 244, 257, 341

Secular perturbation theories, 172, 181 Seeger, C.L., 620 Sekisan-koden, 159, 166 Seki Takakazu, 155, 164 Senmyō-reki, 154, 156, 159 Serendipity, 591-596, 609, 613 Seungjeongwon Ilgi, 209–221 Sextans region, 457 Sextant, 275, 276, 302, 305 Shadow bands, 285 Shain, A., 390, 410, 420, 421, 458 Shain Cross, 577, 578, 582 Shane, C.D., 266, 317 Sharpless, S., 412, 564 Shellfish, 88 Sheridan, K., 410, 482, 492, 509, 511, 513. 516, 522, 523, 532, 536, 539, 598, 599, 611, 621 shi. 13. 160 Shibukawa Harumi, 155, 156, 159 Shibukawa Kagesuke, 155 Shilla Kingdom (Korea), 45, 46, 52 Shinzo Shinjo, 22 Shiraz (Iran), 122, 123 Shklovsky, I.S., 424, 561 Shoku-Nihongi, 140 Shoku-Nihon-Kôki, 140 Short duration solar bursts, 383, 600 Short-wave radio fade outs, 387, 556 Shoushi-li, 155 Showakusei, 182 Shrines, 86, 87, 91, 112 Shushu-jiuzhang, 165 SILLIAC, 450, 451 Sillok, 210-213, 215-219 Sinclair, M., 434, 438 Single-frequency observations, 591, 610 Slee, B., 245, 247, 265, 379-425, 481-523, 527-540, 545, 547-583, 589-623 Slotted waveguide array, 424, 619 Slowly-varying component, 399, 400, 575, 580 Small Magellanic Cloud, 415, 424, 472-475 Smerd, S., 392, 395, 397, 483, 515, 517, 518, 536 539, 540, 569, 610, 619, 620, 570609 Smith, F. Graham, 264, 402, 403, 424, 490 Snakes, 48, 108 Solar bursts, 383, 387, 391, 423, 425, 482, 515, 523, 527, 529, 532, 534, 544, 595, 597, 598, 600, 611, 619-623 Solar cycle, 218, 400, 495, 556, 575, 580, 594 Solar eclipse, 5, 21–42, 45–52, 54, 140–142. 144, 145, 150-151, 178, 192, 193, 210, 243-332, 339-371, 381, 387, 391-395,

401. 421, 424, 548, 551-552, 554, 565, 571, 573, 574, 581, 592, 595, 608, 609, 617-621 Solar flares, 500-501, 504, 509, 536, 597, 613.618 Solar grating array, 379, 394-401, 422, 425, 554, 556, 557, 559, 560, 565, 568, 570, 575,600-602 Solar limb, 226, 341, 504, 515, 597, 618 Solar magnetic field, 332 Solar Maximum Mission, 613 Solar Noise Group, 391, 547, 548, 551 Solar noise storms, 618 Solar outbursts, 387, 556 Solar parallax, 226, 233 Solar physics, 329-331, 356, 392, 482, 523, 529, 535, 580, 590, 605, 611, 623 Solar radio astronomy, 423, 481–523, 539, 545, 548, 551, 589-623 Solar streamers, 294, 330 Solar System, 54, 179, 188, 189, 226, 239 Solar wind, 421, 613 Solstice, 64, 71, 73, 76, 78, 88-94, 96, 98, 99, 101, 104, 105, 109, 111, 112, 114-117, 157, 160-163 Sôma Diagram, 28, 32-34, 36-38, 40 Source fluctuations, 403 Source size, 422, 595 Southern Hemisphere, 64, 108, 228, 239, 415, 418, 457, 582, 623 South Galactic Pole, 470 Southworth, G.C., 617 Soviet Union, 412, 424, 441, 561, 606 Space weather, 536, 613 Spaniards, 112 Spectrographs, 251-253, 282, 284, 286, 287, 289, 291, 292, 294, 300, 301, 306, 311, 312, 316-318, 321, 328, 330 Spectroheliographs, 400, 555, 575 Spectroscopy, 227, 283, 339, 345, 346, 356, 358-360, 362, 364-366, 369, 370, 484 Spectrum analyser, 482-484, 527, 545, 598 Spiral arms, 412, 416-418, 462, 464, 467, 468, 564, 581 Springs, 85, 87, 263, 266-271, 356, 367, 562 S.S. Swatara, 235–237, 239 Stackpole Brothers, 230, 231 Stairways, 87, 88, 96 Stanford University (USA), 265, 621 Stanier, H.M., 391, 399, 400, 422, 554-556 Stankevitch, K.S., 435 Stanley, G., 380, 402, 434, 435, 438, 439, 483, 551, 562, 594, 605

Index

Star catalogues, 122, 178 Star maps, 122, 131, 199-207 Stars, 3, 4, 6, 10, 11, 13, 49, 51, 55, 62, 63, 65, 67. 69. 70. 74. 87. 94. 121-138. 142. 175, 178, 179, 181, 182, 184, 189-190, 192-194, 201-203, 205, 211, 212, 218, 219, 243, 246, 247, 261, 272, 296, 307, 312-315, 329, 354, 363, 369, 438, 452-454, 462 Statistical analysis, 134, 181-185, 509 Steinberg, J.-L., 425, 619, 620 Stellar evolution, 189 Stewart, R.T., 391, 423, 481-523, 527-540, 589-623 Sūgaku-jojo-Arai, 156-159 Strahan (Australia), 551, 552 Strip integration, 572 Strip scans, 424, 580, 616, 619 Struve, O., 257, 341 Sucancas, 96, 98, 99 Suiko era, 142 Suishu, 147 Sullivan, W.T. III, 379, 412, 425, 441, 475, 481, 544, 545, 547, 548, 580, 590-593, 603, 605, 607 Sumatra (Indonesia), 178, 193, 262, 286-290 Summer solstice, 64, 73 Sunjongwon Ilgi, 209-221 Sunrise, 9-13, 21-42, 64-67, 69, 80, 88, 90-94, 98, 99, 101, 103, 105, 106, 109, 110, 112, 114, 116, 117, 218, 402, 531 Sunset, 8-13, 21-42, 65, 69, 90, 91, 94, 104, 109, 117, 218, 402, 539-540, 551, 552 Sunshine hours, 150 Sunspot areas, 556, 618 Sunspot numbers, 556 Sunspots, 211, 256, 340, 366, 367, 384, 400, 550, 561, 575, 592, 595, 602, 608, 609, 616-618, 621 Supernatural, 62, 91 Supernovae, 54, 65 Supernova remnants, 582 Suzuki, S., 523, 536, 621 Swarup, G., 399, 407, 491, 571, 575, 576, 620, 621 Swasey, A., 265, 308, 315 Swept-frequency interferometer, 482, 491, 492, 495, 501, 509, 511, 514, 515, 532, 533, 604, 611, 615 Swept-phase interferometer, 514 Sydney, 227, 263, 265, 274, 301, 309, 313,

- 380, 387, 389, 423, 425, 434, 436, 438, 441, 450, 454, 481–483, 490, 527, 529–531, 539, 544, 548, 549, 551, 553, 556, 561, 562, 575, 580–582, 589, 594, 595, 598, 600, 602, 603, 605–607, 616–618, 623 Sydney Water Board, 380 Synchrotron emission, 408, 424, 518
- Synodic month, 159, 161

Т

Takebe, Katahiro, 153-168 Takahashi Yoshitoki, 155 Takakura, T., 619 Tanaka, H., 425, 619, 621 Tandberg-Hassen, E., 399, 422, 556 Tang Dynasty (China), 147, 159 Tasimeter, 26, 357, 365-367, 370 Tasmania (Australia), 228, 237, 391, 394, 474, 551, 553 Taurus, 69, 123, 452, 563 Taurus A, 405, 408 Telegraph, 264, 267, 285, 287, 311, 322 Telescope, 80, 81, 182, 185, 229-232, 244-246, 248, 250, 251, 267-274, 276, 279, 285, 287, 288, 303, 305, 308, 312, 317, 323, 328, 346, 348, 350, 352, 358, 360, 366, 381, 382, 385, 408, 421, 424, 481, 483, 500, 523, 534, 565, 577, 580-583, 595, 604, 605, 617, 623 Telescope-maker, 323, 350 Tello, J., 87 Temperature changes, 556, 557 Temperature control, 443 Temple architecture, 75 Temple of Pachacamac (Peru), 86 Tenmu era, 142, 147, 148 Tennant, J.F. (Major-General), 259, 260, 345-348 Tenpō-reki calendar, 155 Terao, Hisashi, 172 Terraces, 95, 107, 111, 113 Thasos (Aegean Sea), 31, 33-35, 38, 41, 42 The Hague (The Netherlands), 620 Themis asteroid family, 174, 175, 181 The Observatory, 356, 412, 450, 564 Theon of Alexandria, 13 Theoretical astronomy, 178, 192 Thermal emission, 408, 556, 604 Thomas, A.B., 402, 403, 494 Thomaston (Georgia, USA), 262, 264, 284-286 Thrones, 95, 105

Thule asteroid group, 180 tian, 13 Tianjing-huowen, 155 Tides, 4, 5, 309, 313 Tigers, 47, 50 Time, 5, 6, 9-11, 14, 15, 22, 23, 26, 32, 36, 46, 56, 62-66, 69, 70, 72, 76, 78-80, 86, 92, 96, 101, 105, 108, 109, 111, 122, 123, 129, 130, 136, 141-143, 145-150, 154-163, 165, 172-176, 182, 189, 191, 200, 203, 204, 206, 216, 218, 219, 226, 234-239, 246-250, 253, 258, 260-262, 266-268, 272-274, 276-281, 283, 285, 289, 292, 300, 303-308, 311, 315, 317, 322, 323, 328, 329, 331, 332, 339-341, 346, 348, 352, 354, 358, 359, 362, 363, 365, 368, 369, 371, 380, 381, 390-392, 395, 400-402, 407, 411, 416-418, 420-425, 434, 436-438, 441-443, 445, 447, 449, 450, 458, 468, 472, 482, 483, 485, 487, 489-493, 495, 498, 501-503, 506, 507, 509, 512, 513, 515, 518, 520, 527, 530-532, 535, 536, 543, 545, 548, 551, 553, 554, 557, 559, 561-563, 575, 577, 580, 581, 583, 593, 594, 598, 600, 604, 605, 607, 611, 615, 616, 619, 621, 623 Time-keeping, 154 Time signals, 266, 267, 278, 281, 285, 306, 311, 317, 322 Timing, 4, 6, 8–14, 16, 18, 19, 226, 317, 356, 388, 421, 591-595 Tipon (Peru), 89 Tirepegur, X., 277 Tiwanaku, 88 Todd, D.P., 233 Tokyo Astronomical Observatory (Japan), 172, 176-179, 182, 183, 185, 190, 193, 619 Tokyo Imperial University (Japan), 172, 176-179, 185, 193, 194 Tomography, 572 Tongkuk Munheon Bigo, 212 Toolangi Magnetic Observatory, 390 Topa Inca, 86, 91 Toshio Watanabe, 23, 26, 28, 35, 40 Totality, 6, 8–10, 12, 13, 15, 248, 259–261, 266, 268, 272, 273, 278, 283, 285, 286, 288-290, 292, 300-302, 306, 308, 309, 311, 316, 317, 319, 322, 328, 331, 345, 348-350, 352-355, 357, 359-361, 365, 366, 370 Toyokawa (Japan), 619, 621

- TPS-3 antennas, 548
- Traité de Mécanique Céleste, 178

- Transistors, 605
- Transit of Venus, 225-239, 302
- Transit of Venus Commission, 229
- Transit radio telescope, 424
- Transmission lines, 492, 495, 512, 558, 559, 570
- Treharne, R.F., 380
- Trent, G.H., 408-410, 420, 523, 532, 621
- Trojan asteroid group, 173, 180
- Tropical year, 159-162
- Trumpler, R., 265, 309, 311, 313, 329
- Tsunami, 141
- Tulse Hill (England), 283
- Tumuli, 45–49
- Turner, H.H., 271, 295, 364
- Type I solar bursts, 384, 499, 501, 506–508, 529, 530, 619, 621
- Type II solar bursts, 385, 482, 486–490, 497, 499, 501, 504–509, 515, 517–521, 529–532, 534, 536, 611–613, 615, 619, 621
- Type III solar bursts, 482, 486–488, 497, 499–502, 506, 515, 517–519, 523, 529–533, 611–613, 619, 621
- Type IV solar emission, 509
- Type V solar bursts, 518–520, 621

U

- Ultraviolet, 595
- Ulugh Bēg, 123, 125
- Underworld, 96, 101, 108
- United States Navy, 297, 315, 317
- Universe, 61-63, 71-74, 76, 435
- Universitats Sternwarte (Kiel), 622
- University of California (USA), 244, 246, 265, 266, 271, 274, 297, 305
- University of Colorado (USA), 621
- University of Melbourne (Australia), 265, 316, 548, 572, 573
- University of Michigan (USA), 620
- University of Oslo (Norway), 621
- University of Sydney (Australia), 450, 481, 548, 549, 580–582, 589, 605, 616
- University of Western Sydney (Australia), 582, 583
- Ursa Minor, 123, 125-127, 131, 132, 135
- URSI Congress (1952), 490
- Urubamba (Peru), 85, 90–92, 94–96, 109–114, 116, 117
- USA, 129, 176, 178, 188, 192, 225–239, 245, 262–271, 284–286, 296, 297, 304–308, 313, 316–322, 339–371, 401, 420, 422–424, 441, 543, 605

U.S. Naval Observatory (USNO), 179, 193, 228, 233, 244, 245, 250, 265, 271, 285, 287, 296, 297, 305, 322, 350, 354, 355, 358, 360, 364

V

Van Allen belts, 613 Variable baseline interferometry, 618-620 Variable stars, 175, 189, 190, 192 Vedanga Jyotisa, 70 Vedic astronomy, 70-76 Venus, 65, 149, 211, 225-239, 260, 302, 341 Vilcashuman, 88, 90 Viracocha, 87, 101 Virgo A. 405 Vitkevich, V.V., 619 Vladivostok, 228, 233 Volcanic eruptions, 141 Volunteers, 228, 262-268, 275, 276, 278, 280-284, 286, 287, 290, 295, 305, 322, 324, 326 Vonberg, D.D., 422, 597, 607, 618 V2 rocket, 595 Vulcan, 253, 254, 260, 288, 289, 291, 292, 294, 296, 302, 303, 367-369, 371

W

Wade, C.M., 410, 411 Walker, R.A., 263, 277, 278 Wallal (Western Australia), 262, 265, 308-314, 324, 329 Warburton, J., 396-402, 422, 437, 440, 557, 559, 560, 567-575 Wasan, 155, 156, 168 Water, 71, 74, 75, 86–91, 94, 95, 100, 104, 109, 112, 116, 154, 268-270, 311, 323, 380, 384, 436, 443 Water channels, 87, 89-91, 94, 95, 104, 116 Water clocks, 154 'Water reservoir' telescope, 268-270, 384 Water supply reservoir, 380 Watheroo Magnetic Observatory (Australia), 557 Wave-meter, 438 Weather, 54, 55, 62, 141, 144, 148, 150, 237, 239, 261, 267, 283, 290, 291, 303-305, 314, 317, 339, 350, 358, 359, 361, 364, 365, 367, 420, 436, 536, 569, 603, 613 Weather records, 54, 55, 141, 144, 148, 150 Weaving, 88 Weishu, 147 Weiss, A., 514-516, 518-521, 536, 539,

612, 615 Wenxian Tongkao, 212 Westerhout, G., 410, 416, 418, 419, 450, 458, 463, 467 Western astronomy, 155, 172 Westfold, K., 380, 408, 502, 504, 515, 544 West, R., 265, 295, 366 White, Sir Frederick, 623 Wild, P., 391, 412, 470, 471, 481-484, 490, 512, 527-540, 543-545, 589, 598 Willard lens, 250 Williams Bay, 283 Wind, 63, 231, 247, 276, 281, 363, 421, 474, 490.613 Winlock, J., 229, 350-352, 360, 363 Winter solstice, 64, 73, 105, 157, 160-163 Women, 88, 89, 151, 244, 309, 324-326, 358, 368 Wood, H., 539 World War I, 303 World War II, 561 Wright, W.H., 244, 265, 266, 288, 314-316, 320, 329, 357 Würzburg antenna, 442 WWII searchlight mirrors, 387, 393 WWV, 443, 445

Х

X-ray crystallography, 573 X-rays, 548, 595, 613 Xu Ang, 159 *Xuanming-li*, 154–156, 158–160

Y

Yabsley, D., 391, 400, 402, 548, 550, 551, 553, 555, 556, 575, 607, 618, 619 Yabuuchi Kiyoshi, 191 Yagi antenna, 421, 594, 597 Yajur Veda, 70, 73 Yale University (USA), 179, 193, 316 Yang Hui, 164 Yanghui-suanfa, 164 Yezo Island (Japan), 279 Yi Dynasty (China), 211, 215 Yonsei University Library, 204, 205 Yoshida Mitsuyoshi, 155, 156 Young, C.A., 248, 257-260, 328, 340-342, 354, 365, 368, 370 Young, C.W., 621 Yuan Dynasty (China), 155 yuga, 71, 78-80

Z

Zeeman effect, 505 zenith telescope, 182, 185 Zhanguo Period, 22, 23 Zhelezniakov, V.V., 515 *zhis*, 160 zigzag channels, 88, 100 Zīj, 123 ziqpu stars, 10–12 Ziwei Yuan Tianyi, 219, 220 Zodiac, 69, 78, 123, 125 zodiacal constellations, 65 Zuoshi-zhuan, 22, 23, 25, 26 Z-term in latitude variation, 172, 176, 184–185