

Index

- Adelaide and Tasmania, Universities of:
 research group, 65, 91, 136
- Aerobee, *see* rockets
- Air Force, US, *see* X-ray astronomy
 (funding for)
- Aller, L., 32
- American Astronomical Society, 31
- American Rocket Society, 29
- American Science and Engineering, Inc.:
 history of, 35–6
- American Science and Engineering, Inc.
 research group: discovery of X-ray
 sources, 4, 42–6, 52–3, 65, 89; funding,
 70, 136; instruments, 90, 128, 142;
 neutron star model, 84; research
 programs, 37–46, 92–9; *see also*
 Giacconi, R.; Uhuru
- Annis, M., 35
- Appleton, E. V., 12
- aspect problem, *see* rockets
- Assman, R., 10
- astronomers: ground-based, 31, 65, 96,
 116; as migrants into X-ray astronomy,
 4, 63
- Astronomy Missions Board (NASA), 57,
 68
- Atomic Energy Commission, 71
- attitude control systems, *see* rockets
- Baez, A., 40
- balloons, 10, 11, 64–5
- Barnett, M. A. F., 12
- Bell, J., 101
- Berkeley, University of California at:
 research group, 107–8, 136
- Berkner, L. V., 31
- black hole, *see* models (binary accretion)
- Bondi, H., 55
- Bose, S. N., 80
- Bowyer, C. S., 52, 107
- Breit, G., 12
- Bronk, D. W., 31
- Burbidge, G., 55, 60, 81, 98
- Burbidge, M., 81
- Burnight, T. R., 18, 19
- Bish, V., 27
- Byram, E. T., 22
- Cambridge University radio astronomy
 group, 88, 92
- Cameron, A. G. W., 81
- Chapman, S., 13–14
- Charles, J. A. C., 9
- Chiu, H. Y., 81–2, 86
- Chubb, T. A., 21–2, 88, 101
- Clark, G. W., 92; balloon use by, 64; and
 gamma ray astronomy, 63; neutron star
 theory, 84; on Russian space science,
 67; work with AS&E group, 35, 37, 40,
 78
- collimators, 88, 128, 140–2; modulation
 collimators, 92–4, 95, 141–2
- Columbia University research group, 110,
 136
- Compton, A. H., 11
- Conference on X-Ray Astronomy (1960),
 40, 46
- Congress, US, House Committee on
 Science and Astronautics, 69–70, 128;
 and space program, 2, 68–70; and X-ray
 astronomy, 57, 69–70, 128
- Conner, J. P., 71–2
- cosmic rays, 42; early research on, 10–12;
see also detectors
- cosmology: and radio astronomy, 54, 56;
 big bang theory, 54–5, 100–1, 105;
 steady state theory, 55, 88; and soft
 X-radiation, 106–9
- Crab Nebula: as a gamma ray source, 63;
see also X-ray sources

184 *Index*

- Department of Defense, Advanced Research Projects Agency, 71
- detectors: absorption in, 143; use of anticoincidence techniques with, 42, 88, 114, 140; cosmic ray, 34; deficiencies of, 32, 106–7, 109–10; Geiger counters, 1, 11, 18, 21, 22, 33, 39, 41–2, 43, 51, 65, 71, 84, 88, 139–40; use of modulation collimators with, 93–4, 95, 110; proportional counters, 52, 71, 84, 113, 139–40; pulse shape discrimination, 114, 140; scintillation counters, 42, 63, 64, 84–5, 139–40; for solar X-ray astronomy, 18, 22, 38, 51; trends in design, 99, 128; X-ray telescope, 38–40, 57, 123
- Dirac, P. A. M., 80
- Dornberger, W. R., 16
- Edison, T. A., 13, 55
- Edlen, B., 14
- Einstein, A., 80
- Einstein (HEAO-2 satellite), 123
- Eisenhower, D. D., 28, 29
- electromagnetic spectrum: atmospheric windows in, 2, 3
- Explorer satellites, 35, 57, 63
- Fazio, G. G., 50
- Felton, J. E., 78, 105
- Fermi, E., 80
- Field, G. B., 106, 107
- Finzi, A., 103
- Fisher, P. C., 50, 57, 111; *see also* Lockheed Missiles and Space Company research group.
- Fowler, W., 81
- Friedman, H., 5, 35, 37, 38, 57, 78; background and education, 18–21; discovery of nonsolar X-ray source, 33, 49; leadership in X-ray astronomy, 49, 53, 72–3; and neutron star theory, 79–86; rocket astronomy, 26; on satellite use, 104; solar X-ray astronomy, 21, 49; ultraviolet astronomy, 25; X-ray astronomy research programs, 52, 53, 87–91, 99, 110–11; *see also* Naval Research Laboratory research group.
- Gagarin, Y., 68
- gamma ray astronomy, 50, 63–4
- Gamow, G., 54, 80
- Giacconi, R., 4, 49, 57; background and education, 36, 37; discovery of X-ray sources, 42–6; hopes for X-ray astronomy, 38, 40; leadership in X-ray astronomy, 53, 72–3; X-ray astronomy research programs, 40, 87, 92–9; and X-ray astronomy satellites, 5, 57, 123; X-ray telescope, 38–40, 123
- Gieryn, T. F., 60–1
- Ginzburg, V. L., 67, 98
- Goddard Space Flight Center (NASA), 49, 65, 83, 136
- Gold, T., 35, 55, 101, 103
- Goldberg, L., 17
- Gorenstein, P., 93, 114
- Gould, R. J., 55, 60, 66
- Grasberger, W., 32, 35
- Grottrian, W., 14
- Gursky, H., 46
- Hayakawa, S., 96–7
- Heaviside, O., 12
- Heise, J., 119
- Henry, R. C., 106, 107–8
- Henry, L., 32, 35
- Hess, V. F., 10
- Hewish, A., 101
- Hey, J. S., 55
- high-altitude research, 9, 16, 64; *see also* meteorology; cosmic rays; balloons; rockets.
- High Energy Astronomical Observatories (HEAO), 57, 123, 129–30
- Hoyle, F., 55, 60, 66, 81
- Hulbert, E. O., 13, 14, 17, 21
- Institute for Advanced Studies (Princeton University), 84
- International Geophysical Year, 27, 28–9, 31
- interplanetary plasma, 35, 40–1
- ionospheric research, 4, 12–14, 17
- Johnson, H. M., 95
- Johnson, L. B., 30
- Kennedy, J. F., 68
- Kennelly, A. E., 12
- Killian, J. R., 29
- Kirkpatrick, P., 40
- Kraushaar, W. L., 63–4, 108–9
- Kupperian, J. E., 40, 49, 50, 83
- Lavoisier, A. L., 10
- Lawrence Radiation Laboratory research group, 32, 70–1, 85–6, 90, 91, 136
- Leach, R. W., 119
- Leicester, University of: research group, 65, 136
- Lockheed Missiles and Space Company research group: funding, 70, 136; history, 49, 50; satellite experiment, 111; source discoveries, 89, 90, 91, 95; *see also* Fisher, P. C.

- Los Alamos Scientific Laboratory research group, 34, 50, 71–2, 136
- Lovell, A. C. B., 56
- Lyman, T., 18
- Lyot, B., 14
- Manchester University Jodrell Bank radio astronomy group, 92
- Marconi, G., 12
- Mark, H., 70
- Matsuoka, M., 96–7
- Massachusetts Institute of Technology research group, 34, 101–2, 117, 128, 136, 142; *see also* Clark, G. W.
- meteorology, 9–10
- military services, US, support for astronomy, 2, 41
- Millikan, R. A., 10, 11
- models: binary accretion, 5, 96–7, 98, 99, 117–21; pulsar, 100, 101–4
- Morrison, P., 63, 78, 105
- Morton, D. C., 82, 84, 86
- Mount Palomar Observatory, 82, 96
- National Academy of Sciences, 84; debate over NASA, 29; on space research, 31–3; Space Science Board, 31, 34–5, 57, 68; on X-ray astronomy, 32, 57, 68, 129
- National Advisory Committee on Aeronautics, 29–30
- National Aeronautics and Space Administration (NASA): creation, 3–4, 29–30; funding for X-ray astronomy, 40, 49, 50, 51, 57, 67, 68–70; 128–9; 136–7; space science program, 30–1, 68
- Naval Research Laboratory: history of, 12–13
- Naval Research Laboratory research group, 16, 30; and background radiation, 107–8; Crab Nebula experiment, 79–86; entrance into X-ray astronomy, 52, 53; funding, 70, 136; research program, 87–91, 100, 110–11; solar X-ray astronomy, 22; *see also* Friedman, H.
- neutron stars: history of concept, 5, 79–81; *see also* models (binary accretion)
- Newell, H. E., 30, 31
- Nixon, R. M., 129
- Nuclear Test Ban Treaty (1963), 70–1
- nuclear weapons laboratories, 70–2
- Oda, M., 67, 93, 96
- Office of Naval Research, 16, 70
- Oppenheimer, J. R., 81
- Orbiting Astronomical Observatories, 111, 112
- Orbiting Solar Observatory, 65
- Penzias, A., 105
- Peterson, L. E., 64
- physicists: as high-altitude investigators, 9, 10–12; as migrants to X-ray astronomy, 4, 5, 62–3, 64, 93
- Prendergast, K., 98
- President's Science Advisory Committee, 57, 129
- public policy: for space research, 4, 5–6, 27–31, 127–30; *see also* Congress, US; X-ray astronomy (funding for)
- pulsars, 101–4; *see also* models; radio sources
- radio astronomy: background radiation, 105; and cosmology, 54, 56; history, 55–6, 79, 87, 92; optical identifications, 92; surveys, 87–8
- radio sources: 3C273, 90–1; M87, 90; Cygnus A, 55, 56–7, 87, 90; nomenclature, 89; pulsars, 101; quasars, 56, 79, 90, 92
- radio transmissions, 12
- Reber, G., 55
- Rice University research group, 65, 136
- Rochester, University of: research group, 49–50
- Rocket and Satellite Research Panel, 29
- rockets, 14, 17, 65, 109; Aerobee, 23, 24, 25, 41, 83–4, 88, 94, 98, 100; aspect problem, 23; attitude control systems, 83, 90, 94, 98, 100, 128; Jupiter, 29; Nike-Asp, 41; V-2, 14, 15, 16, 23; Vanguard, 29; Viking, 16
- rocket astronomy, 21–5
- Roman, N., 63, 68
- Rossi, B.: and AS&E research program, 7, 41, 45; background, 11, 34, 35; and potential of X-ray astronomy, 35, 57; and Scorpius X-1, 98; and thermal bremsstrahlung radiation mechanism, 78–9; and X-ray telescope, 39
- Ruffini, R., 119
- Ryle, M., 127
- Salisbury, J. W., 41, 46
- Sandage, A., 96
- Sandia Laboratories, 71
- San Diego, University of California at: research group, 64–5, 136
- satellites, 82, 111, 123, 128; *see also* High Energy Astronomical Observatories; Orbiting Astronomical Observatories; Orbiting Solar Observatory; Uhuru; Vela.
- Savedoff, M. P., 49–50
- Schmidt, M., 56
- Seward, F. D., 70, 71, 72

186 *Index*

- Shaw, N., 10
 Shklovsky, J. S., 67, 83, 98, 102
 Simpson, J. A., 32
 Small Astronomy Satellite-1 (SAS-1), *see* Uhuru
 Smith, W. B., 62
 solar X-ray astronomy: emission mechanisms of solar X-rays, 14, 22; features of solar X-rays, 22, 37, 138–9; first discoveries in, 18, 21; impact on nonsolar X-ray astronomy, 4, 25; research at the NRL, 4, 21–6; X-ray spectrum, 17, 22–3
 Soviet Union: space science research, 4, 22, 67; *see also* Sputnik
 Space General Corporation, 83
 Sputnik, impact of, 4, 27–9, 127
 stellar evolution, 25, 52, 80–1
 Stine, H., 28
 Sun, 1, 4, 13–14, 17–18, 23, 37–40, 45, 52, 77, 78, 83, 98; *see also* solar X-ray astronomy
 supernovae, 119; history of concept, 80; physics of, 81; *see also* X-ray sources; models (binary accretion)
 Symington, S., 28
 Taylor, A. H., 13
 technology, trends in, 127–8
 Teisserenc de Bort, L., 10
 Tousey, R., 18
 Tucker, W., 103
 Tuve, M. A., 12
 Uhuru (SAS-1): compared to rockets, 121–2; discoveries made by, 5, 65, 112, 116–17; funding of, 99, 128; history, 57, 72, 112–13; instruments on, 113–15; origin of name, 112; pictured, 36, 115; purpose, 112
 ultraviolet astronomy, 23–5
 Van Allen, J. A., 23
 van den Heuvel, E. P. J., 119
 Vegard, L., 14
 Vela satellites, 71–2
 Von Braun, W., 16
 Watson-Watt, R. A., 12
 white dwarfs, 80, 81, 98
 Wilson, A., 9
 Wilson, R., 105
 Wisconsin, University of: research group, 64, 107, 108–9, 137
 Wolf, R. A., 103
 Wolter, H., 38–9
 Woltjer, L., 110
 X-radiation: features of, 18, 138–9; units, 138–9
 X-radiation mechanisms, 37, 40; blackbody, 40, 78, 81, 85–6, 142–3; bremsstrahlung, 22, 37, 40, 55, 78–9, 85–6, 103, 109, 110, 118, 119, 142–3; in discrete wavelengths, 22; inverse Compton effect, 78, 105, 142–3; recombination emissions, 22, 37; synchrotron, 37–8, 78, 81–2, 85, 102–3, 109, 110, 142–3
 X-ray astronomers, 4; experimentalists, 62–3, 65–6, 72, 134–5; interrelationship with other astronomers, 65; migrants, 4, 5, 62, 64, 67, 93; national origins, 66–7, 134–5; number, 58–61; from optical and radio astronomy, 66, 134–5; publication habits, 67; research activity, 58–60; theoreticians, 65, 66, 134–5; training, 66–7
 X-ray astronomy: first discoveries in, 1, 4, 42–6; funding for, 5, 6, 40, 41, 68–70, 112, 128–30, 136–7; immediate implications of, 54–5; potential impact of, 35, 55–8
 X-ray sources: 3C273, 90–1; background, 44, 53, 54, 100, 104–9, 121; Centaurus X–3, 116, 117, 118, 121; Centaurus X–4, 72; Crab Nebula (Taurus X–1), 32, 38, 41, 46, 53, 64, 77, 81–6, 88, 89, 91, 92, 96, 100, 101, 103, 109, 110, 112, 117, 121, 122; Cygnus X–1, 91, 117, 119, 121; Cygnus X–2, 98–99; evolution of, 119–21; general features of, 88–91, 96, 99; Hercules X–1, 117, 118; in Lupus, 72; in Milky Way Galaxy, 90, 107, 121; Moon, 40; nomenclature, 89; physics of, 58, 77–86, 117–19; predictions of, 32–3, 38, 40, 50–1; pulsars, 102, 103–4, 109, *see also* X-ray sources (Crab Nebula); Scorpius X–1, 1, 4, 46, 53, 54, 64, 65, 71, 72, 78, 79, 83, 84–6, 88, 89, 92, 93, 94, 96–8, 99, 100, 103, 104, 110, 112, 117, 121, 128, 138–9, 141, 142; Small Magellanic Cloud, 108; Sun, 41, *see also* solar X-ray astronomy; supernovae, 91, 92, 94, *see also* X-ray sources (Crab Nebula)
 X-ray spectra, 104, 110, 139, 142–3
 Zwicky, F., 80