Japanese Aerospace Literature This month: *Astrophysics*

A89-45644 Hybrid solution of the solar neutrino problem in anticorrelation with sunspot activity. HISAKAZU MINAKATA and HIROSHI NUNOKAWA, *Physical Review Letters* (ISSN 0031-9007), Vol. 63, July 10, 1989, pp. 121-124. 19 Refs.

A mechanism for a new type of solution to the solar neutrino problem is proposed which provides a natural explanation for the observation that the solar neutrino flux is apparently in anticorrelation with the sunspot number. The mechanism is found to require the simultaneous presence of neutrino flavor mixing and a magnetic (or transition) moment as large as muB of about 10 to the -10th, where mu is in units of the Bohr magneton and B is in kG. The present mechanism results in an about 20 percent deficit in the net neutrino flux. It is pointed out that for low energy pp-chain neutrinos, the spin rotation does not play an important role.

A89-45285 Rapidly rotating general relativistic stars. II - Differentially rotating polytropes. HIDEMI KOMATSU, YOSHIHARU ERIGUCHI, and IZUMI HACHISU, *Royal Astronomical Society, Monthly Notices* (ISSN 0035-8711), Vol. 239, July 1, 1989, pp. 153-171. 24 Refs.

A previous numerical method (Komatsu, 1989) has been applied to the study of general relativistic differentially rotating bodies, including ring-like structures. Nine sequences for polytropic index (N) = 1/2 polytropes and 10 sequences for N = 3/2 polytropes have been computed for various values of the rotation parameter and the strength of gravity. For both general-relativistic and weak-Newtonian gravities, models have been obtained for the limiting cases of nearly rigid rotation and strongly differential rotation. It is found that the increase in the gravitational mass by rotation is considerably suppressed in the strong-gravity limit.

A89-44951 Unstable neutrino reheating of the universe and distortion of cosmic background radiation spectrum. M. FUKUGITA, M. KAWASAKI, and T. YANAGIDA, *Astrophysical Journal, Part 2 - Letters* (ISSN 0004-637X), Vol. 342, July 1, 1989, pp. L1-L4. 22 Refs.

It is shown that the unstable neutrino reheating describes correctly the distortion of the cosmic background radiation spectrum in a short-wavelength side of the peak, if reheating occurs between z = 100,000 and 10,000 by the neutrino with mass greater than about 20 keV and the photon branching ratio fixed by the energetics condition. Other astrophysical consequences of reheating are studied in detail.

A89-44910 On the interrelation between the surface photometric parameters and the internal velocities of galaxies. KEICHI KODAIRA, *Astrophysical Journal, Part 1* (ISSN 0004-637X), Vol. 342, July 1, 1989, pp. 122-127. 26 Refs.

The interrelations between the surface photometric parameters and the internal velocities are explored by means of the principal component analysis and the regression line analysis of homogeneous data for 18 elliptical and 28 spiral galaxies of moderate inclinations in the Virgo Cluster. Extremely tight correlations are found both for ellipticals and spirals, between the visual magnitude and a combined parameter involving the internal velocity and the isophotal diameter of galaxies. The physical meaning of the parameter is inferred to be a sort of phase-space density related to the basic structure of galaxies, and its empirical behavior in the diameter versus surface brightness diagram is briefly described.

A89-42252 Evolution of perturbations in a baryon-dominated universe -Gauge-invariant analysis. NAOTERU GOUDA, MISAO SASAKI, and YASUSHI SUTO, *Astrophysical Journal, Part 1* (ISSN 0004-637X), Vol. 341, June 15, 1989, pp. 557-574. Research supported by the University of California. 64 Refs.

The evolution of scalar (density) perturbations in a baryon-dominated universe is comprehensively studied on the basis of a gauge-invariant method. In particular, the residual anisotropies of the cosmic microwave background radiation are calculated and are compared with the recent observational upper limits. To the extent that the universe has not been reionized after recombination, the observed upper limits of the temperature anisotropies on small angular scales rule out the cosmological models without nonbaryonic dark matter. In turn, this would provide strong support for (nonbaryonic) dark matter, independently of the results of standard primordial nucleosynthesis. Reionization after recombination, if any, might allow an isocurvature baryonic universe as a viable model, only when the initial density power spectrum was very steep.

A89-19891 Ionization structure of the gaseous halo in our Galaxy. MASANAO ITO and SATORU IKEUCHI, *Astronomical Society of Japan, Publications* (ISSN 0004-6264), Vol. 40, No. 4, 1988, pp. 403-411. 22 Refs.

The ionization structure of the gaseous halo in the Galaxy is reexamined on the basis of the photoionization model for a plane-stratified halo gas. The calculated column densities of principal ions like H I, C IV, Si IV, and N V are compared with the IUE data, and the probable ranges of the temperature and density of the halo gas are deduced. To reproduce the distribution of column densities of these four ions at z = 0.1-10 kpc, at least three gas components are necessary.

A89-41475 The heliosphere as an astrophysical laboratory for particle acceleration. T. TERASAWA and M. SCHOLER, *Science* (ISSN 0036-8075), Vol. 244, June 2, 1989, pp. 1050-1057. 30 Refs.

The heliosphere offers an ideal object of astrophysical study, where phenomena whose understanding is of fundamental importance to particle-acceleration processes, such as stochastic acceleration in the MHD turbulence around comets and stochastic shock acceleration at interplanetary shock waves, can be intensively observed. In both these phenomena, the particles interact during their acceleration with an MHD turbulent-wave field of their own making, creating a problem that is of highly nonlinear character; nonlinearities that are not included in the quasi-linear treatment may accordingly have very significant consequences.

A89-41214 Detailed comparison of transverse magnetic fields of the sun with H-alpha fine structures. SINGO KAWAKAMI, MITSUGU MAKITA, and HIROKI KUROKAWA, *Astronomical Society of Japan, Publications* (ISSN 0004-6264), Vol. 41, No. 1, 1989, pp. 175-195. 14 Refs.

Vectormagnetograms obtained at the Okayama Astrophysical Observatory are compared in detail with H-alpha filtergrams taken with the Domeless Solar Telescope at Hida Observatory for three active regions. The coincidence rate between the azimuth of transverse magnetic fields and elongated H-alpha dark fine structures decreases as the active region moves on the solar disk from the center to the limb. This center-to-limb variation of the azimuthal coincidence rate can be explained by the difference of elevation angle between the photospheric and chromospheric magnetic fields. The analysis of three active regions shows that, in a more active region, the magnetic field is more inclined in the photosphere, and more sheared in the vertical direction. Three active regions show different values of the azimuthal coincidence rate, and these differences are discussed in connection with the magnetic field configuration and the evolutional characteristics of the individual active regions.

A89-41211 A model of astrophysical tori with magnetic fields. RIKA OKADA, JUN FUKUE, and RYOJI MATSUMOTO, *Astronomical Society of Japan, Publications* (ISSN 0004-6264), Vol. 41, No. 1, 1989, pp. 133-140. 29 Refs.

A steady axisymmetric model of MHD tori is constructed under the assumptions that the specific angular momentum is constant in the whole space and the magnetic field has only the toroidal component. Furthermore, the gas is assumed to be polytropic, and the magnetic field is supposed to be expressed by a power of the density and the radius in some specified manner. The relativistic effect is simulated by use of a pseudo-Newtonian potential. It is found that the configuration of the torus with a toroidal magnetic field is elongated along the symmetry axis because of the dominance by the magnetic field far from the axis.

A89-37124 Prototype thin superconducting solenoid for particle astrophysics in space. T. MITO, A. YAMAMOTO, Y. MAKIDA, T. HARUYAMA, H. INOUE et al., *IEEE Transactions on Magnetics* (ISSN 0018-9464), Vol. 25, March 1989, pp. 1663-1666. 7 Refs.

A description is given of a prototype magnetic which is a very thin and lightweight superconducting solenoid 1 in in diameter, 1.3 m in length and a 1.27 central field. The authors plan to use this device in balloon experiments scheduled for 1990 to measure high-energy cosmic rays as preliminaries to the experiment in space. They have constructed the model magnet, which is the same size as the prototype magnet and has 1/4 superconducting wire and 3/4 dummy wire. The cooling, exciting, and quench properties of this magnet were measured and compared with design values to verify the coil winding technique and the static indirect cooling method using pure aluminum.

A89-16426 A normal-mode analysis of a class of self-gravitating stellar disks with differential rotation. MINEO SAWAMURA, *Astronomical Society of Japan, Publications* (ISSN 0004-6264), Vol. 40, No. 3, 1988, pp. 279-311. 25 Refs.

A normal-mode analysis for unstable modes is performed on a class of self-gravitating, rotating, and collisionless stellar disks with finite radius. Results are presented on the bar mode, unstable modes caused by the differential rotation, the one-armed mode, and winding senses.

A89-16427 Line-profile variations due to nonradial oscillations in rapidly rotating stars. EIJI KAMBE and YOJI OSAKI, *Astronomical Society of Japan, Publications* (ISSN 0004-6264), Vol. 40, No. 3, 1988, pp. 313-329. 21 Refs.

Line-profile variations due to nonradial oscillations in rapidly rotating stars are investigated by calculating theoretical line profiles in a wide range of relevant parameters. Toroidal modes as well as spheroidal modes are considered. The main characteristics of line-profile variations are summarized in terms of two parameters: one specifying the pulsational mode and another specifying the aspect of the stellar rotation and pulsation axis to the observer, i.e., the inclination.

A89-36256 Neutrino energy loss in stellar interiors. III - Pair, photo-, plasma, and bremsstrahlung processes. NAOKI ITOH, TOMOO ADACHI, MASAYUKI NAKAGAWA, YASUHARU KOHYAMA, and HIROHARU MUNAKATA, *Astrophysical Journal, Part 1* (ISSN 0004-637X), Vol. 339, April 1, 1989, pp. 354-364. 26 Refs.

Detailed results of the calculation of the neutrino energy-loss rates due to pair, photo-, plasma, and bremsstrahlung processes corresponding to the density-temperature regime 1-10 to the 14th g/cu cm, 10 to the 7th - 10 to the 11th K are presented. The calculation is based on the Weinberg-Salam theory. The present calculation is the most accurate calculation to date covering the widest density-temperature regime. The discrepancies with the previous works are carefully examined. Extensive tables are prepared to show the detailed results of the photo-neutrino energy-loss rate.

A89-35183 Rapidly rotating general relativistic stars. I - Numerical method and its application to uniformly rotating polytropes. HIDEMI KOMATSU, YOSHIHARU ERIGUCHI, and IZUMI HACHISU, *Royal Astronomical Society, Monthly Notices* (ISSN 0035-8711), Vol. 237, March 15, 1989, pp. 355-379. 26 Refs.

The Newtonian self-consistent field method has been generalized to the general relativistic case as a means of modeling the structures of rapidly rotating relativistic stars. The method is used to compute uniformly rotating polytropic stars having polytropic indices N = 1/2, 3/2, and 3 for several values of gravitational strength. For the case of strong gravity, the configurations of rotating stars resemble Newtonian polytropes having much higher polytropic indices.

A89-34974 Structure of magnetized accretion disks and origin of astrophysical jets. TOMOYUKI HANAWA, HIROTAKA KAMAHORI, TETSUJI MARUYAMA, and KAZUNARI SHIBATA, *Astronomical Society of Japan, Publications* (ISSN 0004-6264), Vol. 40, No. 6, 1988, pp. 729-750. 47 Refs.

A model is presented for an accretion disk with large-scale magnetic fields. The radial, vertical, and overall structure of the disk are examined numerically. The gas distribution and magnetic field configuration are obtained. It is found that the upper part of the model accretion disk is unstable against the magnetic buoyancy instability. The role of this instability is discussed in relation to the formation of bipolar jets.

A89-30354 Dust grains in M 104 - An interpretation of the optical polarization in an external galaxy. M. MATSUMURA and M. SEKI, *Astronomy and Astrophysics* (ISSN 0004-6361), Vol. 209, No. 1-2, Jan. 1989, pp. 8-14. 19 Refs.

The properties of the polarization due to light scattering by dust in a spheroidal galaxy, modeled on the Sombrero (M104), are studied. The pattern of polarizations in the outer region of the galaxy is found to be almost circular, while the polarization near the center is perpendicular to the major axis of the galaxy. This indicates that the influence of the shape of the galaxy on polarization becomes appreciable near the center of the galaxy. The results are compared with the observation of M104 by Scarrott (1987), and the upper limit of mass of cool gas is estimated to be 0.7-2 x 10 to the 8th solar masses in the spheroidal part where the surface brightness in the B band is brighter than 23.0 mag/sq arcsec. The radial distribution of dust in the disk is also obtained from the polarization observed along the major axis of the galaxy.

A89-28868 Toward observational neutrino astrophysics. M. KOSHIBA, *Proceedings of the Fourth George Mason Astrophysics Workshop, Supernova 1987A in the Large Magellanic Cloud,* Fairfax, VA, Oct. 12-14, 1987 (A89-28851 11-90). Cambridge and New York, Cambridge University Press, 1988, pp. 130-150. Research supported by MOESC. 41 Refs.

Ways of developing the field of neutrino astrophysics are examined. The developments leading up to the observation of the neutrino burst from SN 1987A and the real-time, directional, and spectral observation of solar B-8 neutrinos are reviewed. Consideration is given to the implications of these discoveries, and methods for solar neutrino observation. Also, the use of the Imaging Water Cerenkov method in low-energy neutrino astrophysics, the study of high-energy point sources, and the possible development of a network of neutrino-astronomical observatories are discussed.

A88-45984 Appearance of the trans-field flow in the pulsar magnetosphere. SHINPEI SHIBATA, *Royal Astronomical Society, Monthly Notices* (ISSN 0035-8711), Vol. 233, July 15, 1988, pp. 405-422. 25 Refs.

A numerical simulation is performed for an axially symmetric and charge-separated magnetosphere of a neutron star with a circular flow which comes out from the neutron stars, suffers a strong relativistic acceleration causing the trans-field flow, and returns to the star. The location of the acceleration causing the trans-field flow is obtained as a function of the poloidal current density, and is found to be dependent on the magnetic field. It is shown that the magnetic field is determined by the convection current produced by the flow. The magnetic field structure is found to be closed. Relations between pulse period, pulse width, and poloidal current density are derived by means of the converged model and a marginal condition for the pair creation.

A89-20501 Performance analysis of direct N-body calculations. JUNICHIRO MAKINO and PIET HUT, *Astrophysical Journal Supplement Series* (ISSN 0067-0049), Vol. 68, Dec. 1988, pp. 833-856. Research supported by the Alfred P. Sloan Foundation. 15 Refs.

A theoretical framework for analyzing the computational cost of gravitational N-body codes is introduced and applied to three different types of direct-summation codes, including the type of Aarseth code which has found most general use. The method of analysis, based on the probability distribution of nearest-neighbor distances, is described. The number of time steps required for a variety of different versions of the Aarseth scheme and a variety of physical models of spherical star clusters is estimated in order to measure the effects of different degrees of central concentration. Analytical estimates of computer time required are compared with actual measurements, and the validity of the scaling outside the range actually tested is discussed. A practical result for planning star cluster simulations on the next generation of supercomputers is derived. It is found that the consumption of computer time can be very centrally concentrated.

A89-19890 Formation of the bubbly universe by cumulative explosions. SATOSHI YOSHIOKA and SATORU IKEUCHI, *Astronomical Society of Japan, Publications* (ISSN 0004-6264), Vol. 40, No. 4, 1988, pp. 383-401. 25 Refs.

The scale of structures of the universe which can be produced in the explosion scenario is investigated. Solving the equation of motion of an expanding shell produced by cosmic explosions based on the thin-shell approximation, it is shown that it is possible that bubbles of size about 40 Mpc are formed by successive explosions starting from the first-generation objects. However, the observed isotropy of the microwave background radiation limits the bubble size to less than about 30 Mpc in the simple explosion scenario.

A89-19050 A magnetodynamic mechanism for the heating of emerging magnetic flux tubes and loop flares. YUTAKA UCHIDA and KAZUNARI SHIBATA, *Solar Physics* (ISSN 0038-0938), Vol. 116, No. 2, 1988, pp. 291-307. 38 Refs.

A magnetodynamic loop flare model is proposed which can explain such solar activity maximum phenomena as the blueshifted lines of Ca XIX and Fe XXV appearing before the intitiation of impulsive bursts and relaxing into the unshifted lines by the time of the onset of impulsive bursts. The energy supply to the loop top is modeled as coming from below the chromosphere before the flare in the form of relaxing fronts of magnetic twist of opposite sign. Released packets of magnetic twist produce a hot region at the loop top and annihilate the magnetic energy.

A89-18993 Note on secular perturbations between a retrograde body and a prograde body. HIROSHI KINOSHITA and HIROSHI NAKAI, *Celestial Mechanics* (ISSN 0008-8714), Vol. 42, No. 1-4, 1987-1988, pp. 279-292.

Hirayama (1927) studied secular perturbations between a retrograde body and a prograde body by considering that the mean motion of the retrograde body is negative. This paper considers the same problem by measuring angle variables from the departure point and keeping the mean motions positive for both the retrograde body and the prograde body. The analytical solutions are compared with numerically integrated orbits.

A89-16428 Dust properties in the Kleinmann-Low Nebula. YOSHIKAZU NAKADA, *Astronomical Society of Japan, Publications* (ISSN 0004-6264), Vol. 40, No. 3, 1988, pp. 331-340. 34 Refs.

Dust properties in the Kleinmann-Low Nebula are studied by comparing the available intensity profiles in the far-IR with a power-law type model. The physical parameters of the source, i.e., the distribution of the dust density, the distribution of the dust temperature, the dust emissivity, and the optical depth of the cloud from the center to the outer edge, and the cloud mass, are estimated. Hydrogenated carbon particles are indicated as the most favorable candidate for the emitter in the source.

A89-16429 Power-law size distribution of dust grains. HISAO HAYAKAWA and SATIO HAYAKAWA, *Astronomical Society of Japan, Publications* (ISSN 0004-6264), Vol. 40, No. 3, 1988, pp. 341-345. 12 Refs.

A power-law size distribution of interstellar dust grains is derived from the coagulation equation with a supply of dust-forming atoms and molecules. Astrophysical conditions required for the power-law distribution are considered.

A88-33521 Nonlinear pulsations of discrete stellar models. III - Adiabatic motions of a two-zone model. TOSHIKI AIKAWA and CHARLES A. WHITNEY, *Astrophysical Journal, Part 1* (ISSN 0004-637X), Vol. 328, May 1, 1988, pp. 187-195. 22 Refs.

Oscillations of two-shell model for a star undergoing nonlinear conservative pulsation are compared with those of a low-order approximation of the fully nonlinear model. Behavior of the fully nonlinear model differs significantly from the predictions of the low-order approximation whose equipotential curves show saddle-points not found in the fully nonlinear models. It is concluded that low-order approximations artificially induce strong nonlinear effects and so are not valid indicators of the onset of chaos in conservative models with few degrees of freedom.