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Russian and Japanese Aerospace Literature

Throughout 1993 the *AIAA Journal* will carry selected abstracts on leading research topics from Russian aerospace literature and, as space permits, from similar Japanese literature. The topics will be chosen and the abstracts reviewed for pertinency by *AIAA Journal* editors. This month features Integrated Optics from Russia and Astronomy from Japan.

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Russian Aerospace Literature This month: *Integrated Optics*

A92-40647 Using optical means for data transmission and processing in multiprocessor computer systems (Ispol'zovanie opticheskikh sredstv dlia peredachi i obrabotki informatsii v mnogoprotsessornykh vychislitel'nykh kompleksakh). V. P. TORCHIGIN, *Avtometriia* (ISSN 0320-7102), No. 1, Jan.–Feb. 1992, pp. 11–17. 6 Refs.

Various methods of integrating optical devices for discrete data processing and data transmission into massively parallel computer systems are examined. It is shown that the specific features of optical data processing are closely compatible with the specific characteristics of such systems, resulting in the automatic multiplication of all the devices in time. The possibility of adapting an optical computer system to a specific problem at no additional cost provides for an additional increase in the general efficiency of the system.

A92-33722 Theory of optical mode coupling in thin-film integrated optic and acoustooptic structures (Teoriia sviazi opticheskikh mod v tonkoplenochnykh strukturakh integral'noi optiki i akustooptiki). A. A. BARYBIN and M. G. STEPANOVA, *Zhurnal Tekhnicheskoi Fiziki* (ISSN 0044-4642), Vol. 61, Oct. 1991, pp. 120–126. 13 Refs.

A general theory for optical mode coupling is presented which is based on the theory of waveguide excitation by specified currents. The problem is solved in self-consistent form in the presence of static and parametric excitation with allowance for both the discrete and continuous spectra of open structures. A system of coupled equations is obtained, and mode coupling coefficients are determined for different frequencies. The equations are applicable to the analysis of physical phenomena underlying the operation of integrated optic and acoustooptic devices.

A92-32044 Functional possibilities of a Sagnac fiber interferometer as a microphasometer (Funktsional'nye vozmozhnosti volokonnogo interferometra San'iaka kak mikrofazometra). I. A. ANDRONOVA, V. M. GELIKONOV, IU. A. MAMAEV, and A. A. TURKIN, *Radiofizika* (ISSN 0021-3462), Vol. 34, April 1991, pp. 412–418. 10 Refs.

The paper examines the feasibility of using a fiber ring interferometer as an equal-armed microphasometer to measure phase modulation which can arise under various types of physical effects (acoustic signal, magnetic field, etc.). Attention is given to conditions for obtaining the maximum detector sensitivity in the case when an optical divider with a quadrature shift is placed in the ring or when additional phase modulation is used at one of the ends of the fiber ring. The potential of the ring phasometer is demonstrated using a model of a Sagnac all-fiber interferometer at a wavelength of 0.85 micron; the measured limiting sensitivity is 3 x 10 exp -7 rad.

A92-40646 Electrooptical implementation of cellular data processing structures (Elektroopticheskaia realizatsiia kletochnykh struktur obrabotki dannykh). O. L. BANDMAN, *Avtometriia* (ISSN 0320-7102), No. 1, Jan.–Feb. 1992, pp. 3–11. Refs.

A method is proposed for the synthesis of a structure of electrooptical cellular processors implementing an algorithm contained in a parallel microprogram. Two objectives are pursued: to show the potential of electrooptical components in the implementation of parallel computer structures and to demonstrate the efficiency of parallel microprogramming techniques in the design and analysis of cellular optical devices. The synthesis of an optical multiplier structure is examined as an example.

A92-28385 Spin waveguides for integrated microwave devices (Spinovye volnovody dlia integral'nykh ustroistv SVCh). E. O. KAMENETSKII and O. V. SOLOV'EV, *Radioelektronika* (ISSN 0021-3470), Vol. 34, Nov. 1991, pp. 3–7. 15 Refs.

The available experimental data on narrow spin waveguides are reviewed. In particular, attention is given to structures placed in a transverse tangential magnetic field, with homogeneous and inhomogeneous distribution over the waveguide width. Possible applications of such spin waveguides include integrated microwave devices with a planar structure for signal processing.

A92-28317 Transitions between bistable states in an external-cavity injection laser under current modulation (Perekhody mezhdu bistabil'nymi sostoianiiami inzhektsionnogo lazera s vneshnim rezonatorom pri moduliatsii tokom). IU. A. BYKOVSKII, I. G. GONCHAROV, S. I. KOVAL', *Kvantovaia Elektronika* (ISSN 0368-7147), Vol. 18, Nov. 1991, pp. 1306–1308. 10 Refs.

The possibility of fast current switchings of an external-cavity injection laser by stationary bistable states due to short-period changes in the concentration of excess carriers is shown. For a switching duration of 10 ns, the switching energy amounted to 0.1 pJ.

A92-28306 Self-switching of radiation in three tunnel-coupled waveguides (O samoperekliuchenii izluchenila v trekh tunnel'no-sviazannykh volnovodakh). A. A. MAIER, *Kvantovaia Elektronika* (ISSN 0368-7147), Vol. 18, Oct. 1991, pp. 1264–1266. 15 Refs.

The self-switching of radiation in three tunnel-coupled optical waveguides is investigated analytically for the case where the coupling between the waveguides is substantial. The self-switching and gain characteristics of a system of three tunnel-coupled waveguides are discussed in comparison with the case of two tunnel-coupled waveguides.

A92-28355 The effect and the removal of the effect of the signal phase on signal amplification in tunnel-coupled waveguides (O vliianii i ustranenii vliianiia fazy signala na ego usilenie v tunnel'no-sviazannykh volnovodakh). A. A. MAIER, *Kvantovaia Elektronika* (ISSN 0368-7147), Vol. 18, Dec. 1991, pp. 1447–1453. 10 Refs.

Attention is given to positive and negative aspects of the influence of the signal phase on radiation self-switching in tunnel-coupled optical waveguides and on the operation of optical transistors, amplifiers, and multivibrators on the basis of this phenomenon. Attention is given to variants of the switching method in which the effect of the phase of the weak alternating signal on the process of its differential amplification is removed. Optical multivibrators which are resistant to the instability of the wave phase increment in the feedback circuit are proposed and studied.

A92-28337 Optical-signal-controlled logical elements for computers (Logicheskie elementy dlia komp'iuterov, upravliaemye opticheskimi signalami). V. P. TORCHIGIN, V. A. KOSTRIUKOV, O. B. ROMANOVA, and E. V. SPORYSHEV, *Kvantovaia Elektronika* (ISSN 0368-7147), Vol. 18, Nov. 1991, pp. 1374–1378. 8 Refs.

The operation of an all-optical light switch utilizing distributedly coupled nonlinear waveguides is considered. The switch is a hybrid of the Mach-Zehnder interferometer and a nonlinear directional coupler. This element is shown to operate at signal powers which are approximately six times lower than the Mach-Zehnder interferometer. Attention is given to the capacities for producing optical gates utilizing these elements and controlled by optical signals, and their characteristics are presented.

A92-27623 Design principles of optical echo processors (Printsipy postroeniia opticheskikh ekho-protsessorov). E. A. MANYKIN and N. A. CHERNYSHEV, *Kvantovaia Elektronika* (ISSN 0368-7147), Vol. 18, Sept. 1991, pp. 1127–1130. 17 Refs.

The paper examines the utilization of the photon echo (PE) phenomenon in connection with the optical digital processing of discrete images on the basis of the method of control operators. Different PE excitation modes can be used in practically all the component parts of the processor, making it possible to use the PE phenomenon for optical data processing.

A92-27570 Nonlinear light transfer in coupled Rb:KTP waveguides (Nelineinaia perekachka sveta v sviazannykh Rb:KTP-volnovodakh). K. S. BURITSKII, E. M. DIANOV, V. A. MASLOV, V. A. CHERNYKH, and E. A. SHCHERBAKOV, *Kvantovaia Elektronika* (ISSN 0368-7147), Vol. 18, Aug. 1991, pp. 983, 984. 8 Refs.

The transmission of subnanosecond light pulses through a system of coupled channel waveguides produced in the KTP crystal is studied. When the input signal was increased to 5 kW, the nonlinear transfer of 40 percent of the light power from one channel to another was observed.

A92-23476 A generalized parametric model of locally recursive structure implementation in three-dimensional integrated circuits (Obobshchennaia parametricheskaia model' realizatsii lokal'no-rekursivnykh struktur v trekhmernykh integral'nykh skhemakh). M. B. IGNAT'EV and IA. KOMORA, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 320, No. 5, 1991, pp. 1058–1062. 4 Refs.

An attempt is made to extend the parametric model for systolic structures proposed by Li and Wah (1985) to a random locally recursive algorithm with z data streams for z greater than 3. Such an effort is relevant to a possible implementation of three-dimensional homogeneous computational structures in the form of three-dimensional integrated circuits. An important result of the analysis presented here is that an increase in the number of data streams not only has no detrimental effect on the parameters of homogeneous computational structures but, on the contrary, may actually improve the parameters of such structures.

A92-16690 Optically controlled periodic structure based on a dielectric waveguide (Opticheski upravliaemaia periodicheskaia struktura na osnove dielektricheskogo volnovoda). V. V. GUSAKOV, N. P. DEMCHENKO, L. I. KATS, and I. S. NEFEDOV, *Radiotekhnika i Elektronika* (ISSN 0033-8494), Vol. 36, Nov. 1991, pp. 2095–2101. 6Refs.

The present study demonstrates the basic feasibility of an optically controlled EHF-range phase-shifter based on control of electromagnetic-wave propagation in a periodic structure formed by changing the effective permittivity of the medium as optically excited charge carriers arise in a high-resistance semiconductor. Results of calculations and experimental studies are presented regarding the phase-shifting properties of a semiconductor plate on whose surface a series of interference bands is produced optically.

A92-10892 The characteristics and applications of self-diffraction in light waves with noncollinear polarizations (Osobennosti i primeneniia samodifraktsii svetovykh voln s nekollinearnymi poliarizatsiiami). N. N. ZHUKOV, O. P. ZASKAL'KO, I. G. KUZNETSOV, *Kvantovaia Elektronika* (ISSN 0368-7147), Vol. 18, May 1991, pp. 603–610. 7 Refs.

The paper examines the characteristics of unsteady self-diffraction in two waves with different polarizations in an isotropic medium with scalar response. It is shown that this effect can be used for developing a polarization shutter, which, in addition to switching the signal, can amplify the signal wave. A method is proposed for measuring the degree of temporal coherence of light beams, including those with a well-developed unsteady speckle structure. The validity of the method is experimentally demonstrated.

A92-23473 Convolution of circuit models in determining the functional static stability of logic devices (Svertyvanie modelei skhem pri opredelenii funktsional'noi staticheskoi ustoichivosti logicheskikh ustroistv). G. IA. KERDIVARA, A. A. MASLOV, M. A. KMETA, and V. N. BELICHUK, *Elektronnoe Modelirovanie* (ISSN 0204-3572), Vol. 13, Nov.–Dec. 1991, pp. 51–54. 2Refs.

A newly developed engineering method for the analysis of the logic stability is presented. The method is used in determining the functional static stability of logic devices through the convolution of logic-stability circuit models, from the transfer characteristics of the base logic elements to highly complex LSIC microprocessor circuits.

A92-18195 Optimization of the parameters of optical channel waveguides for second harmonic generation (Optimizatsiia parametrov kanal'nykh svetovodov dlia generatsii vtoroi garmoniki). E. T. AKSENOV, A. A. LIPOVSKII, V. A. MOTKOV, and V. IU. PETRUN'KIN, *Zhurnal Tekhnicheskoi Fiziki* (ISSN 0044-4642), Vol. 61, May 1991, pp. 72–78. 7Refs.

A method is presented for calculating the parameters of optical channel waveguides in lithium niobate optimized for optical frequency doubling. By using the approach proposed here, optimal parameters are determined for an integrated optical frequency doubler operating at a wavelength of 1.3 microns.

A92-11860 Excitation of surface acoustic waves in Rb:KTP. K. S. BURITSKII, E. M. DIANOV, A. B. KISELEV, V. A. MASLOV, and E. A. SHCHERBAKOV, *Electronics Letters* (ISSN 0013-5194), Vol. 27, Oct. 10, 1991, pp. 1896, 1897. 3Refs.

For the first time the excitation of surface acoustic waves (SAWs) by means of interdigital transducers has been realized in Rb:KTP crystals. The speed of the SAW of 3.9 km/s and the insertion loss of 29 dB were measured at a frequency of 240 MHz.

A92-10985 Efficient TM-pass multilayer planar optical waveguide polariser. A. IU. AGAPOV, A. P. GOROBETS, V. M. SHEVTSOV, and P. M. ZHITKOV, *Electronics Letters* (ISSN 0013-5194), Vol. 27, Sept. 26, 1991, pp. 1804, 1805. 4Refs.

A novel TM-pass polarizer using the form birefringence of a stratified periodic medium is proposed. The mode-filter properties of a planar waveguiding structure with form birefringent buffer layer on a lossy substrate are investigated numerically. A structure with TM0-mode attenuation of less than 3 dB/cm at 633 nm and TE-mode losses exceeding 300 dB/cm has been demonstrated experimentally.

A91-45045 Transmission of femtosecond solitons through a fiber-optic loop (Prokhozhdenie femtosekundnykh solitonov cherez volokonno-opticheskuiu petliu). E. A. ZAKHIDOV, F. M. MIRTADZHIEV, D. V. KHAIDAROV, A. V. KUZNETSOV, and O. G. OKHOTNIKOV, *Institut Obshchei Fiziki, Moscow,* USSR) Kvantovaia Elektronika (ISSN 0368-7147), Vol. 18, March 1991, pp. 333–336. 10Refs.

Theoretical and experimental results are presented on the transmission and switching of fundamental femtosecond-duration solitons in a fiber-optic loop (FOL), an element suitable for logic operations. It is shown that efficient filtering of solitons from the nonsoliton component can be achieved in the FOL. Conditions for the high-contrast self-switching of the fundamental solitons in an FOL are found.

A91-33160 Development of numerical integration methods in the subsystems of the computer-aided design of electronic circuits (Analytical review) (Razvitie metodov chislennogo integrirovaniia v podsistemakh avtomatizirovannogo proektirovaniia elektronnykh skhem /Analiticheskii obzor/). A. I. PETRENKO and A. I. TSIRFA, *Elektronnoe Modelirovanie* (ISSN 0204-3572), Vol. 13, Jan.–Feb. 1991, pp. 30–38. 71 Refs.

The principal features of the existing numerical integration methods used in the analysis of the dynamic regimes of electronic circuits are examined with particular reference to signal shape relaxation methods, increment methods, combined approaches, explicit-implicit methods, and different-step methods. Possible ways of improving the efficiency of numerical integration in electronic circuit analysis are discussed. Basic approaches are selected which can be used as the starting point in developing efficient numerical integration algorithms for mathematical models of a wide class of electronic circuits.

A90-44998 Broadening of the bandwidth and improvement of the efficiency of integrated optical traveling-wave modulators (Rasshirenie polosy i uvelichenie effektivnosti integral'no-opticheskikh moduliatorov begushchei volny). E. M. ZOLOTOV, V. M. SUGIMOTO, and R. F. TAVLYKAEV, *Kvantovaia Elektronika* (Moscow) (ISSN 0368-7147), Vol. 17, May 1990, pp. 630–635. 16 Refs

It is shown that a simultaneous broadening of the frequency bandwidth and a reduction in the control power of an integrated optical traveling-wave modulator is possible under electrooptic interaction according to the law of linear-frequency-modulated oscillations, derived using the inverse Fourier transform of rectangular amplitude-frequency and square-law phase-frequency characteristics of the modulator. This law can be realized using planar electrode structures with triangular or trapezoidal toothed edges, in which the tooth-repetition rate is determined by the linear-FM oscillation; the tooth-repetition rate rises as the light is modulated with higher and higher frequencies.

A91-11369 Optical switches, transistors, and multivibrators tolerant to signal phase instability (Opticheskie perekliuchateli, tranzistory i mul'tivibratory, ustoichivye k nestabil'nosti fazy signala). A. A. MAIER, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 312, No. 4, 1990, pp. 855–859. 11 Refs.

The method of optical switching in tunnel-coupled waveguides proposed by Maier (1982) provides a way to create switching elements for optical computers, transistors, multivibrators, and other devices. Here, an application of the method is examined whereby the output characteristics of a switch are independent of the input signal phase. Optical switches and transistors with output characteristics independent of the input signal phase are described, as are optical multivibrators in which the output wave intensities are independent of the signal phase taper in the feedback circuit.

A90-43021 Integrated optics and magnetic optoelectronics (Integral'naia optika i magnitnaia optoelektronika). V. D. TRON'KO and N. V. SHIMANSKAIA, *Optoelektronika i Poluprovodnikovaia Tekhnika* (ISSN 0233-7577), No. 17, 1990, pp. 1–10. 31 Refs.

The magnetooptic properties of ferrite-garnet single crystals and single-crystal films and the electrodynamics of wave propagation in planar magnetic structures are investigated. Integrated devices based on ferrite-garnet films and their applications are discussed. The factors that currently limit the use of magnetooptic materials in integrated optics are examined, and specific fundamental and applied problems are identified in which the use of magnetooptics would be beneficial.

A90-26413 A finned dielectric line and some devices based on it (Reberno-dielektricheskaia liniia i nekotorye ustroistva na ee osnove). V. I. GVOZDEV, E. I. NEFEDOV, T. IU. CHERNIKOVA, and V. A. SHEPETINA, *Radiotekhnika i Elektronika* (ISSN 0033-8494), Vol. 35, Feb. 1990, pp. 298–305. 12 Refs.

A method for the rigorous electrodynamic analysis of a finned dielectric line (a type of guide structure for microwave integrated circuits) is developed. The approach used is based on the method of partial domains and systems of integral equations which are algebraized using the Galerkin method. Experimental results are presented concerning regular finned dielectric lines and a number of elements based on them (e.g., loads, excitation devices, and directional couplers).

A90-39487 Waveguide mode diffraction by a finite system of ribbons in a layered dielectric (Difraktsiia volnovodnykh voln na konechnoi sisteme lent v sloistom dielektrike). V. A. KUZNETSOV, A. M. LERER, and G. N. SHELAMOV, *Radiofizika* (ISSN 0021-3462), Vol. 33, April 1990, pp. 479–487. 12 Refs.

The paper is concerned with the problem of electromagnetic wave diffraction by an arbitrary number of strips in a metallic waveguide filled with a layered dielectric and by strips located on the surface of a plane dielectric waveguide. The problem is solved by the partial domain method, avoiding the need for considering in explicit form the continuous spectrum for open structure and attenuating modes for closed structures. The results of the study have been used in the synthesis of strip filters based on inductive strips fabricated by integrated circuit technology.

A90-39454 The fin-slot line—Theory, experiment, and devices (Reberno-shchelevaia liniia—Teoriia, eksperiment i ustroistva). V. I. GVOZDEV, G. A. KUZAEV, and V. A. SHEPETINA, *Radiotekhnika i Elektronika* (ISSN 0033-8494), Vol. 35, May 1990, pp. 954–958. 9 Refs.

A transmission line with orthogonal dielectric and plane conductor layers is proposed in which the fins of the conductor layers form a slot structure in the center. The electromagnetic fields of the structure are modeled using a simple method that does not require the full solution of the complex boundary value problem. Based on the results of theoretical and experimental studies, three-coordinate power dividers and three-dimensional radiating structures have been developed.

A90-30391 State of the art and development prospects of neurocomputer technology (Sovremennoe sostoianie i perspektivi razvitiia neirokomp'iuternoi tekhniki). A. V. KALIAEV and G. A. GALUEV, *Elektronnoe Modelirovanie* (ISSN 0204-3572), Vol. 12, Mar.–Apr. 1990, pp. 14–19. 17 Refs.

A neurobionic approach to creating data processing systems is considered. Three possible ways of development are discussed: creating neurocomputers serving as general-purpose computers, employing neurocomputers as coprocessors for general-purpose computers, and designing neurocomputers as parallel neurolike structures. Several types of neurocomputers developed mainly in the U.S.A. and Japan are described and future trends in this field are indicated along with possible application areas.

Japanese Aerospace Literature
This month: *Astronomy*

A92-43720 A survey of CCS, HC3N, HC5N, and NH3 toward dark cloud cores and their production chemistry. HIROKO SUZUKI, SATOSHI YAMAMOTO, MASATOSHI OHISHI, NORIO KAIFU, SHIN-ICHI ISHIKAWA, YASUHIRO HIRAHARA, and SHURO TAKANO, *Astrophysical Journal, Part 1* (ISSN 0004-637X), Vol. 392, No. 2, June 20, 1992, pp. 551–570. Research supported by Morino Science Foundation. 92 Refs.

Survey observations of CCS, HC3N, HC5N, and NH3 were carried out toward 49 dark cloud cores to examine the existence of a systematic relation between the chemical evolution and the physical evolution of dark clouds. The CCS radical was revealed to be abundant in cold and quiescent dark cloud cores, while it is much less abundant in star-forming regions. The column density of CCS shows a good positive correlation with those of HC3N and HC5N, indicating that the production chemistry of CCS is closely related to those of other carbon-chain molecules in dark clouds. On the other hand, the column density of CCS shows no correlation with that of NH3; NH3 tends to be abundant in star-forming regions. A possible chemical model for the production of CnS (n = 1-3) is proposed. Pseudo-time-dependent calculations based on the proposed model show that the calculated abundance of CCS in the early stage of chemical evolution agrees mostly with the observed value in TMC-1. The relations among the observed column densities are qualitatively interpreted as an effect of chemical evolution of dark clouds on the basis of simulation of the molecular synthesis; carbon-chain molecules including CCS are abundant in the early stages of chemical evolution, whereas NH3 is abundant in the later stages.

A92-37742 Canonical time variations of X-rays from black hole candidates in the low-intensity state. SIGENORI MIYAMOTO, SHUNJI KITAMOTO, SAYURI IGA, HITOSHI NEGORO, and KENTARO TERADA, *Astrophysical Journal, Part 2—Letters* (ISSN 0004-637X), Vol. 391, No. 1, May 20, 1992, pp. L21–L24. 20 Refs.

The power spectrum density functions of X-rays and the phase lags of the time variations between different energy X-rays were investigated for several black-hole candidates (Cyg X—1, GX 339—4, and GS 2023 + 338) in their low-intensity state, to determine whether these density functions were different for different X-ray sources and at different occasions for the same source. The results suggest that, in these black hole candidates in the low-intensity state, the X-ray production process and the dynamics of accreting matter behavior are the same except for the processes which correspond to the Fourier frequencies below about 0.2 Hz.

A92-42964 A systematic survey for dense cores in nearby star formation regions. YASUO FUKUI, A. MIZUNO, T. NAGAHAMA, K. IMAOKA, and H. OGAWA, *Societa Astronomica Italiana, Memorie* (ISSN 0037-8720), Vol. 62, No. 4, 1991, pp. 801–812. 20 Refs.

Some of the first results of a survey for dense cores in the C(O-18) J = 1-0 and CS = 2-1 emission in nearby star formation regions are presented. CS J = 2-1 maps covering the Ori A cloud including L1641 and the Rho Oph main cloud, and a C(O-18) map of Taurus as well as (C-13)O maps are provided. High star formation efficiency is found in regions with remarkable concentrations of dense molecular gas; they are the Ori KL region and the Rho Oph main cloud. In low mass dense cores, isolated stars or small low mass clusters appear to be formed. Two stellar clusters with 10-20 low mass members are known to exist in L1641 from near IR studies by Chen et al. (1991). They are associated with L1641-North and L1641-Center outflows, respectively, and are accompanied by low-intensity CS clumps of about 1-2 K km/s peak intensity.

A92-26621 3.3-micron spectra of four IRAS sources. HIROSHI SUTO, KOHEI MIZUTANI, and TOSHINORI MAIHARA, *Astronomical Journal* (ISSN 0004-6256), Vol. 103, March 1992, pp. 927–930. 16 Refs.

The spectra between 3.15 and 3.45 microns are presented for four IRAS sources; IRAS 05355 + 3039, 06294 + 0352, 06335 + 1057, and 06210 + 1432 which possess IRAS spectra similar to reflection nebulae. The prominent emission feature at 3.3 microns of the order of 10 exp -19 W/sq cm has been detected in the four sources, and the adjacent feature at 3.4 microns in two of them. The 3.3-micron band strength is used to derive the contribution of small dust to the overall energy spectrum, which is about 20 percent in the 1-100-micron IR region.

A92-24453 The evolution of a black hole's force-free magnetosphere. ISAO OKAMOTO, *Royal Astronomical Society, Monthly Notices* (ISSN 0035-8711), Vol. 254, Jan. 15, 1992, pp. 192–220. 49 Refs.

The structure of a stationary axisymmetric force-free magnetosphere of a Kerr black hole, and the hole's evolution due to extraction of rotational energy by the Blanford-Znajek process is examined. It is proposed that there is an 'effective' e rgoregion inside the static-limit surface where the densities of 'energy at infinity' and angular momentum off the field are negative. In the outer half of the charged magnetosphere, a pulsar-type centrifugal slingshot wind blows outward, whereas in the inner half, a similar centrifugal slingshot wind blows inward.