Smirnov, Yu. G.

Integral dispersion equation method in the problem on nonlinear waves in a circular waveguide. (English. Russian original) Zbl 1479.78022

Differ. Equ. 57, No. 10, 1333-1340 (2021); translation from Differ. Uravn. 57, No. 10, 1359-1366 (2021).

Summary: We study TE-polarized electromagnetic waves propagating in an inhomogeneous dielectric waveguide of circular cross-section filled with a nonlinear medium where the nonlinearity is described by Kerr's law. The existence of infinitely many nonlinear waves (surface as well as leaky) is proved. Sufficient conditions under which several waves can propagate are found, and the localization domains of the corresponding propagation constants are determined.

MSC:

78A60 Lasers, masers, optical bistability, nonlinear optics
78A50 Antennas, waveguides in optics and electromagnetic theory
78A40 Waves and radiation in optics and electromagnetic theory
35P30 Nonlinear eigenvalue problems and nonlinear spectral theory for PDEs
35Q61 Maxwell equations

Keywords:

waveguide; Kerr's law; nonlinear medium

Full Text: DOI

References:

[1] Akhmediev, N. N.; Ankiewicz, A., Solitons, Nonlinear Pulses and Beams (1997), London: Springer, London · Zbl 1218.35183

[2] Eleonskii, P. N.; Oganes'yants, L. G.; Silin, V. P., Cylindrical nonlinear waveguides, Sov. Phys. JETP, 35, 44-47 (1972)

[3] Smirnov, Y.G. and Valovik, D.V., Nonlinear effects of electromagnetic TMwave propagation in anisotropic layer with Kerr nonlinearity, Adv. Math. Phys., 2012, p. 609765. · Zbl 1251.78011

[4] Smirnov, Y. G.; Valovik, D. V., Calculation of the propagation constants of TM electromagnetic waves in a nonlinear layer, J. Commun. Tech. Electron., 53, 8, 883-889 (2008)· doi:10.1134/S1064226908080044

[5] Kupriyanova, S. N.; Smirnov, Y. G., Propagation of electromagnetic waves in cylindrical dielectric waveguides filled with a nonlinear medium, Comput. Math. Math. Phys., 44, 10, 1762-1772 (2004) · Zbl 1114.78002

[6] Smirnov, Y. G., Propagation of electromagnetic waves in cylindrical dielectric waveguides filled with a nonlinear medium, J. Commun. Tech. Electron., 50, 2, 179-185 (2005)

[7] Smirnov, Y. G.; Schurmann, H.-W.; Schestopalov, Y. V., Integral equation approach for the propagation of te-waves in a nonlinear dielectric cylinrical waveguide, J. Nonlin. Math. Phys., 11, 2, 256-268 (2004) · Zbl 1067.35122 · doi:10.2991/jnmp.2004.11.2.10

[8] Schurmann, H.-W., Smirnov, Y.G., and Shestopalov, Y.V., Propagation of TE-waves in cylindrical nonlinear dielectric waveguides, Phys. Rev. E, 2005, vol. 71, no. 1, pp. 016614-1016614-10.

[9] Smirnov, Y. G.; Smol'kin, E. Y.; Valovik, D. V., Nonlinear transmission eigenvalue problem describing TE wave propagation in two-layered cylindrical dielectric waveguides, Comput. Math. Math. Phys., 53, 7, 973-983 (2013) · Zbl 1299.78015 · doi:10.1134/S096554251307018X

[10] Handbook of Mathematical Functions with Formulas, Graphs and Mathematical Tables, Abramowitz, M., Stegun, I., Natl. Bur. Stand., 1964. Translated under the title: Spravochnik po spetsial'nym funktsiyam s formulami, grafikami i matematicheskimi tablitsami,, Moscow: Nauka, 1979.

[11] Smirnov, Y. G., Eigenvalue transmission problems describing the propagation of TE and TM waves in two-layered inhomogeneous anisotropic cylindrical and planar waveguides, Comput. Math. Math. Phys., 55, 3, 461-469 (2015) · Zbl 1322.78013 · doi:10.1134/S0965542515030173

[12] Smirnov, Yu. G., Integral dispersion equation method for nonlinear eigenvalue problems, Differ. Equations, 56, 10, 1298-1305 (2020) · Zbl 1452.78025 · doi:10.1134/S00122661200100067