References

[1] R. F. Dashen, B. Hasslacher, and A. Neveu, "Nonperturbative methods and extended hadron models in field theory. 2. Two-dimensional models and extended hadrons," *Phys. Rev. D* **10**, 4130 (1974).

[2] A. M. Polyakov, "Particle spectrum in the quantum field theory," *JETP Lett.* **20**, 194 (1974).

[3] T. H. R. Skyrme, "A nonlinear theory of strong interactions," *Proc. Roy. Soc. Lond. A* **247**, 260 (1958).

[4] T. H. R. Skyrme, "Particle states of a quantized meson field," *Proc. Roy. Soc. Lond. A* **262**, 237 (1961).

[5] P. M. Morse and H. Feshbach, *Methods of Theoretical Physics* (New York: McGraw-Hill, 1953), p. 734.

[6] J. Goldstone and R. Jackiw, "Quantization of nonlinear waves," *Phys. Rev. D* **11**, 1486 (1975).

[7] J.-L. Gervais and B. Sakita, "Extended particles in quantum field theories," *Phys. Rev. D* **11**, 2943 (1975).

[8] J.-L. Gervais, A. Jevicki, and B. Sakita, "Perturbation expansion around extended particle states in quantum field theory," *Phys. Rev. D* **12**, 1038 (1975).

[9] C. G. Callan, Jr. and D. J. Gross, "Quantum perturbation theory of solitons," *Nucl. Phys. B* **93**, 29 (1975).

[10] N. H. Christ and T. D. Lee, "Quantum expansion of soliton solutions," *Phys. Rev. D* **12**, 1606 (1975).

[11] E. Tomboulis, "Canonical quantization of nonlinear waves," *Phys. Rev. D* **12**, 1678 (1975).

[12] M. Creutz, "Quantum mechanics of extended objects in relativistic field theory," *Phys. Rev. D* **12**, 3126 (1975).

[13] R. Rajaraman and E. J. Weinberg, "Internal symmetry and the semiclassical method in quantum field theory," *Phys. Rev. D* **11**, 2950 (1975).

[14] R. Jackiw and C. Rebbi, "Solitons with fermion number 1/2," *Phys. Rev. D* **13**, 3398 (1976).

[15] R. Jackiw and J. R. Schrieffer, "Solitons with fermion number 1/2 in condensed matter and relativistic field theories," *Nucl. Phys. B* **190**, 253 (1981).

[16] R. Rajaraman, "Intersoliton forces in weak coupling quantum field theories," *Phys. Rev. D* **15**, 2866 (1977).

[17] N. S. Manton, "The force between 't Hooft–Polyakov monopoles," *Nucl. Phys. B* **126**, 525 (1977).

[18] N. S. Manton, "An effective Lagrangian for solitons," *Nucl. Phys. B* **150**, 397 (1979).

[19] J. K. Perring and T. H. R. Skyrme, "A model unified field equation," *Nucl. Phys.* **31**, 550 (1962).

[20] R. F. Dashen, B. Hasslacher, and A. Neveu, "Nonperturbative methods and extended hadron models in field theory. I. Semiclassical functional methods," *Phys. Rev. D* **10**, 4114 (1974).

[21] R. F. Dashen, B. Hasslacher, and A. Neveu, "The particle spectrum in model field theories from semiclassical functional integral techniques," *Phys. Rev. D* **11**, 3424 (1975).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016

[22] R. Easther, J. T. Giblin, Jr, L. Hui, and E. A. Lim, "New mechanism for bubble nucleation: Classical transitions," *Phys. Rev. D* **80**, 123519 (2009).
[23] J. T. Giblin, Jr, L. Hui, E. A. Lim, and I.-S. Yang, "How to run through walls: Dynamics of bubble and soliton collisions," *Phys. Rev. D* **82**, 045019 (2010).
[24] I. L. Bogolyubsky and V. G. Makhankov, "On the pulsed soliton lifetime in two classical relativistic theory models," *JETP Lett.* **24**, 12 (1976).
[25] M. Gleiser, "Pseudostable bubbles," *Phys. Rev. D* **49**, 2978 (1994).
[26] E. J. Copeland, M. Gleiser, and H.-R. Muller, "Oscillons: Resonant configurations during bubble collapse," *Phys. Rev. D* **52**, 1920 (1995).
[27] M. Gleiser and D. Sicilia, "General theory of oscillon dynamics," *Phys. Rev. D* **80**, 125037 (2009).
[28] M. A. Amin and D. Shirokoff, "Flat-top oscillons in an expanding universe," *Phys. Rev. D* **81**, 085045 (2010).
[29] M. P. Hertzberg, "Quantum radiation of oscillons," *Phys. Rev. D* **82**, 045022 (2010).
[30] A. B. Zamolodchikov and A. B. Zamolodchikov, "Relativistic factorized S-matrix in two dimensions having O(N) isotopic symmetry," *Nucl. Phys. B* **133**, 525 (1978).
[31] A. B. Zamolodchikov and A. B. Zamolodchikov, "Factorized S-matrices in two dimensions as the exact solutions of certain relativistic quantum field models," *Annals Phys.* **120**, 253 (1979).
[32] W. E. Thirring, "A soluble relativistic field theory?," *Annals Phys.* **3**, 91 (1958).
[33] S. Coleman, "The quantum sine-Gordon equation as the massive Thirring model," *Phys. Rev. D* **11**, 2088 (1975).
[34] S. Mandelstam, "Soliton operators for the quantized sine-Gordon equation," *Phys. Rev. D* **11**, 3026 (1975).
[35] G. H. Derrick, "Comments on nonlinear wave equations as models for elementary particles," *J. Math. Phys.* **5**, 1252 (1964).
[36] A. M. Polyakov and A. A. Belavin, "Metastable states of two-dimensional isotropic ferromagnets," *JETP Lett.* **22**, 245 (1975).
[37] H. B. Nielsen and P. Olesen, "Vortex line models for dual strings," *Nucl. Phys. B* **61**, 45 (1973).
[38] B. Plohr, "The behavior at infinity of isotropic vortices and monopoles," *J. Math. Phys.* **22**, 2184 (1981).
[39] L. Perivolaropoulos, "Asymptotics of Nielsen–Olesen vortices," *Phys. Rev. D* **48**, 5961 (1993).
[40] L. Jacobs and C. Rebbi, "Interaction energy of superconducting vortices," *Phys. Rev. B* **19**, 4486 (1979).
[41] E. J. Weinberg, "Multivortex solutions of the Ginzburg–Landau equations," *Phys. Rev. D* **19**, 3008 (1979).
[42] C. H. Taubes, "Arbitrary N-vortex solutions to the first order Landau–Ginzburg equations," *Commun. Math. Phys.* **72**, 277 (1980).
[43] R. Jackiw and P. Rossi, "Zero modes of the vortex–fermion system," *Nucl. Phys. B* **190**, 681 (1981).
[44] E. J. Weinberg, "Index calculations for the fermion–vortex system," *Phys. Rev. D* **24**, 2669 (1981).
[45] E. Witten, "Superconducting strings," *Nucl. Phys. B* **249**, 557 (1985).
[46] C. G. Callan, Jr. and J. A. Harvey, "Anomalies and fermion zero modes on strings and domain walls," *Nucl. Phys. B* **250**, 427 (1985).
[47] G. Lazarides and Q. Shafi, "Superconducting strings in axion models," *Phys. Lett.* **151B**, 123 (1985).
[48] A. Vilenkin and E. P. S. Shellard, *Cosmic Strings and other Topological Defects* (Cambridge University Press, 1994).
[49] N. D. Mermin, "The topological theory of defects in ordered media," *Rev. Mod. Phys.* **51**, 591 (1979).
[50] S. Coleman, "Classical lumps and their quantum descendants." In *Aspects of Symmetry*, S. Coleman (Cambridge University Press, 1985).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use , available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016

[51] T. Vachaspati and A. Achucarro, "Semilocal cosmic strings," *Phys. Rev. D* **44**, 3067 (1991).
[52] M. Hindmarsh, "Existence and stability of semilocal strings," *Phys. Rev. Lett.* **68**, 1263 (1992).
[53] M. Hindmarsh, "Semilocal topological defects," *Nucl. Phys. B* **392**, 461 (1993).
[54] A. Achucarro, K. Kuijken, L. Perivolaropoulos, and T. Vachaspati, "Dynamical simulations of semilocal strings," *Nucl. Phys. B* **388**, 435 (1992).
[55] T. Vachaspati, "Vortex solutions in the Weinberg–Salam model," *Phys. Rev. Lett.* **68**, 1977 (1992).
[56] T. Vachaspati, "Electroweak strings," *Nucl. Phys. B* **397**, 648 (1993).
[57] M. James, L. Perivolaropoulos, and T. Vachaspati, "Detailed stability analysis of electroweak strings," *Nucl. Phys. B* **395**, 534 (1993).
[58] A. S. Schwarz, "Field theories with no local conservation of the electric charge," *Nucl. Phys. B* **208**, 141 (1982).
[59] M. G. Alford, K. Benson, S. Coleman, J. March-Russell, and F. Wilczek, "The interactions and excitations of non-Abelian vortices," *Phys. Rev. Lett.* **64**, 1632 (1990).
[60] M. G. Alford, K. Benson, S. Coleman, J. March-Russell, and F. Wilczek, "Zero modes of non-Abelian vortices," *Nucl. Phys. B* **349**, 414 (1991).
[61] M. Bucher, H.-K. Lo, and J. Preskill, "Topological approach to Alice electrodynamics," *Nucl. Phys. B* **386**, 3 (1992).
[62] M. Bucher, K.-M. Lee, and J. Preskill, "On detecting discrete Cheshire charge," *Nucl. Phys. B* **386**, 27 (1992).
[63] J. Preskill and L. M. Krauss, "Local discrete symmetry and quantum mechanical hair," *Nucl. Phys. B* **341**, 50 (1990).
[64] E. Cartan, "La topologie des espaces représentatifs des groupes de Lie," *Œuvres complètes I, 2* (Paris: Éditions du CNRS, 1984), p. 1307.
[65] G. 't Hooft, "Magnetic monopoles in unified gauge theories," *Nucl. Phys. B* **79**, 276 (1974).
[66] P. A. M. Dirac, "Quantized singularities in the electromagnetic field," *Proc. Roy. Soc. Lond. A* **133**, 60 (1931).
[67] D. Zwanziger, "Quantum field theory of particles with both electric and magnetic charges," *Phys. Rev.* **176**, 1489 (1968).
[68] J. S. Schwinger, "Sources and magnetic charge," *Phys. Rev.* **173**, 1536 (1968).
[69] E. Witten, "Dyons of charge $e\theta/2\pi$," *Phys. Lett.* **86B**, 283 (1979).
[70] T. T. Wu and C. N. Yang, "Concept of nonintegrable phase factors and global formulation of gauge fields," *Phys. Rev. D* **12**, 3845 (1975).
[71] J. J. Thomson, "On momentum in the electric field," *Philos. Mag.* **8**, 331 (1904).
[72] I. Tamm, "Die verallgemeinerten Kugelfunktionen und die Wellenfunktionen eines Elektrons im Felde eines Magnetpoles," *Z. Phys.* **71**, 141 (1931).
[73] T. T. Wu and C. N. Yang, "Dirac monopole without strings: Monopole harmonics," *Nucl. Phys. B* **107**, 365 (1976).
[74] H. A. Olsen, P. Osland, and T. T. Wu, "On the existence of bound states for a massive spin-one particle and a magnetic monopole," *Phys. Rev. D* **42**, 665 (1990).
[75] E. J. Weinberg, "Monopole vector spherical harmonics," *Phys. Rev. D* **49**, 1086 (1994).
[76] M. I. Monastyrsky and A. M. Perelomov, "Concerning the existence of monopoles in gauge field theories," *JETP Lett.* **21**, 43 (1975).
[77] H. Georgi and S. L. Glashow, "Unified weak and electromagnetic interactions without neutral currents," *Phys. Rev. Lett.* **28**, 1494 (1972).
[78] T. W. Kirkman and C. K. Zachos, "Asymptotic analysis of the monopole structure," *Phys. Rev. D* **24**, 999 (1981).
[79] K. Lee and E. J. Weinberg, "Nontopological magnetic monopoles and new magnetically charged black holes," *Phys. Rev. Lett.* **73**, 1203 (1994).
[80] E. J. Weinberg and A. H. Guth, "Nonexistence of spherically symmetric monopoles with multiple magnetic charge," *Phys. Rev. D* **14**, 1660 (1976).
[81] E. B. Bogomolny, "Stability of classical solutions," *Sov. J. Nucl. Phys.* **24**, 449 (1976).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016

[82] M. K. Prasad and C. M. Sommerfield, "An exact classical solution for the 't Hooft monopole and the Julia–Zee dyon," *Phys. Rev. Lett.* **35**, 760 (1975).
[83] E. J. Weinberg, "Parameter counting for multimonopole solutions," *Phys. Rev. D* **20** (1979) 936.
[84] A. Jaffe and C. Taubes, *Vortices and Monopoles* (Boston: Birkhäuser, 1980).
[85] N. H. Christ, A. H. Guth, and E. J. Weinberg, "Canonical formalism for gauge theories with application to monopole solutions," *Nucl. Phys. B* **114**, 61 (1976).
[86] B. Julia and A. Zee, "Poles with both magnetic and electric charges in non-Abelian gauge theory," *Phys. Rev. D* **11**, 2227 (1975).
[87] R. Jackiw and C. Rebbi, "Spin from isospin in a gauge theory," *Phys. Rev. Lett.* **36**, 1116 (1976).
[88] P. Hasenfratz and G. 't Hooft, "Fermion–boson puzzle in a gauge theory," *Phys. Rev. Lett.* **36**, 1119 (1976).
[89] A. S. Goldhaber, "Spin and statistics connection for charge–monopole composites," *Phys. Rev. Lett.* **36**, 1122 (1976).
[90] C. Callias, "Index theorems on open spaces," *Commun. Math. Phys.* **62**, 213 (1978).
[91] V. A. Rubakov, "Adler–Bell–Jackiw anomaly and fermion number breaking in the presence of a magnetic monopole," *Nucl. Phys. B* **203**, 311 (1982).
[92] C. G. Callan, Jr., "Disappearing dyons," *Phys. Rev. D* **25**, 2141 (1982).
[93] C. G. Callan, Jr., "Dyon–fermion dynamics," *Phys. Rev. D* **26**, 2058 (1982).
[94] A. S. Blaer, N. H. Christ, and J.-F. Tang, "Anomalous fermion production by a Julia–Zee dyon," *Phys. Rev. Lett.* **47**, 1364 (1981).
[95] A. S. Blaer, N. H. Christ, and J.-F. Tang, "Fermion emission from a Julia–Zee dyon," *Phys. Rev. D* **25**, 2128 (1982).
[96] P. Klimo and J. S. Dowker, "Dirac monopoles for general gauge theories," *Int. J. Theor. Phys.* **8**, 409 (1973).
[97] F. Englert and P. Windey, "Quantization condition for 't Hooft monopoles in compact simple Lie groups," *Phys. Rev. D* **14**, 2728 (1976).
[98] P. Goddard, J. Nuyts, and D. I. Olive, "Gauge theories and magnetic charge," *Nucl. Phys. B* **125**, 1 (1977).
[99] E. Lubkin, "Geometric definition of gauge invariance," *Annals Phys.* **23**, 233 (1963).
[100] R. A. Brandt and F. Neri, "Stability analysis for singular non-Abelian magnetic monopoles," *Nucl. Phys. B* **161**, 253 (1979).
[101] S. Coleman, "The magnetic monopole fifty years later." In *The Unity of Fundamental Interactions*, ed. A. Zichichi (New York: Plenum, 1983).
[102] A. Sinha, "SU(3) magnetic monopoles," *Phys. Rev. D* **14**, 2016 (1976).
[103] Yu. S. Tyupkin, V. A. Fateev, and A. S. Shvarts, "Existence of heavy particles in gauge field theories," *JETP Lett.* **21**, 41 (1975).
[104] E. J. Weinberg, D. London, and J. L. Rosner, "Magnetic monopoles with Z_n charges," *Nucl. Phys. B* **236**, 90 (1984).
[105] C. P. Dokos and T. N. Tomaras, "Monopoles and dyons in the SU(5) model," *Phys. Rev. D* **21**, 2940 (1980).
[106] C. L. Gardner and J. A. Harvey, "Stable grand unified monopoles with multiple Dirac charge," *Phys. Rev. Lett.* **52**, 879 (1984).
[107] G. Lazarides and Q. Shafi, "The fate of primordial magnetic monopoles," *Phys. Lett.* **94B**, 149 (1980).
[108] A. Abouelsaood, "Are there chromodyons?," *Nucl. Phys. B* **226**, 309 (1983).
[109] P. C. Nelson and A. Manohar, "Global color is not always defined," *Phys. Rev. Lett.* **50**, 943 (1983).
[110] A. P. Balachandran, G. Marmo, N. Mukunda, J. S. Nilsson, E. C. G. Sudarshan, and F. Zaccaria, "Monopole topology and the problem of color," *Phys. Rev. Lett.* **50**, 1553 (1983).
[111] A. P. Balachandran, G. Marmo, N. Mukunda, J. S. Nilsson, E. C. G. Sudarshan, and F. Zaccaria, "Nonabelian monopoles break color. I. Classical mechanics," *Phys. Rev. D* **29**, 2919 (1984).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016

[112] A. P. Balachandran, G. Marmo, N. Mukunda, J. S. Nilsson, E. C. G. Sudarshan, and F. Zaccaria, "Nonabelian monopoles break color. II. Field theory and quantum mechanics," *Phys. Rev. D* **29**, 2936 (1984).
[113] P. A. Horvathy and J. H. Rawnsley, "Internal symmetries of nonabelian gauge field configurations," *Phys. Rev. D* **32**, 968 (1985).
[114] P. A. Horvathy and J. H. Rawnsley, "The problem of 'global color' in gauge theories," *J. Math. Phys.* **27**, 982 (1986).
[115] H. Guo and E. J. Weinberg, "Instabilities of chromodyons in SO(5) gauge theory," *Phys. Rev. D* **77**, 105026 (2008).
[116] V. A. Rubakov, "Superheavy magnetic monopoles and proton decay," *JETP Lett.* **33**, 644 (1981).
[117] C. G. Callan, Jr., "Monopole catalysis of baryon decay," *Nucl. Phys. B* **212**, 391 (1983).
[118] F. Wilczek, "Remarks on dyons," *Phys. Rev. Lett.* **48**, 1146 (1982).
[119] S. Dawson and A. N. Schellekens, "Monopole catalysis of proton decay in SO(10) grand unified models," *Phys. Rev. D* **27**, 2119 (1983).
[120] A. H. Guth, "The inflationary universe: A possible solution to the horizon and flatness problems," *Phys. Rev. D* **23**, 347 (1981).
[121] D. A. Kirzhnits and A. D. Linde, "Macroscopic consequences of the Weinberg model," *Phys. Lett.* **42B**, 471 (1972).
[122] L. A. Dolan and R. Jackiw, "Symmetry behavior at finite temperature," *Phys. Rev. D* **9**, 3320 (1974).
[123] S. Weinberg, "Gauge and global symmetries at high temperature," *Phys. Rev. D* **9**, 3357 (1974).
[124] D. A. Kirzhnits and A. D. Linde, "Symmetry behavior in gauge theories," *Annals Phys.* **101**, 195 (1976).
[125] S. Coleman and E. J. Weinberg, "Radiative corrections as the origin of spontaneous symmetry breaking," *Phys. Rev. D* **7**, 1888 (1973).
[126] A. H. Guth and E. J. Weinberg, "Could the universe have recovered from a slow first-order phase transition?," *Nucl. Phys. B* **212**, 321 (1983).
[127] A. H. Guth and E. J. Weinberg, "Cosmological consequences of a first-order phase transition in the SU(5) grand unified model," *Phys. Rev. D* **23**, 876 (1981).
[128] T. W. B. Kibble, "Topology of cosmic domains and strings," *J. Phys. A* **9**, 1387 (1976).
[129] M. B. Einhorn, D. L. Stein, and D. Toussaint, "Are grand unified theories compatible with standard cosmology?," *Phys. Rev. D* **21**, 3295 (1980).
[130] A. Vilenkin, "Gravitational field of vacuum domain walls and strings," *Phys. Rev. D* **23**, 852 (1981).
[131] A. Vilenkin, "Gravitational field of vacuum domain walls," *Phys. Lett.* **133B**, 177 (1983).
[132] J. Ipser and P. Sikivie, "Gravitationally repulsive domain wall," *Phys. Rev. D* **30**, 712 (1984).
[133] Ya. B. Zeldovich, I. Yu. Kobzarev, and L. B. Okun, "Cosmological consequences of a spontaneous breakdown of a discrete symmetry," *JETP* **40**, 1 (1975).
[134] T. Vachaspati, *Kinks and Domain Walls: An Introduction to Classical and Quantum Solitons* (Cambridge University Press, 2006).
[135] N. Bevis, M. Hindmarsh, M. Kunz, and J. Urrestilla, "Fitting CMB data with cosmic strings and inflation," *Phys. Rev. Lett.* **100**, 021301 (2008).
[136] R. Battye and A. Moss, "Updated constraints on the cosmic string tension," *Phys. Rev. D* **82**, 023521 (2010).
[137] T. W. B. Kibble, "Cosmic strings reborn?," [astro-ph/0410073].
[138] J. Polchinski, "Introduction to cosmic F- and D-strings," [hep-th/0412244].
[139] Ya. B. Zeldovich and M. Y. Khlopov, "On the concentration of relic magnetic monopoles in the universe," *Phys. Lett.* **79B**, 239 (1978).
[140] J. Preskill, "Cosmological production of superheavy magnetic monopoles," *Phys. Rev. Lett.* **43**, 1365 (1979).
[141] E. N. Parker, "The origin of magnetic fields," *Astrophys. J.* **160**, 383 (1970).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016

[142] M. S. Turner, E. N. Parker, and T. J. Bogdan, "Magnetic monopoles and the survival of galactic magnetic fields," *Phys. Rev. D* **26**, 1296 (1982).
[143] F. C. Adams, M. Fatuzzo, K. Freese, G. Tarle, R. Watkins, and M. S. Turner, "Extension of the Parker bound on the flux of magnetic monopoles," *Phys. Rev. Lett.* **70**, 2511 (1993).
[144] Y. Rephaeli and M. S. Turner, "The magnetic monopole flux and the survival of intracluster magnetic fields," *Phys. Lett.* **121B**, 115 (1983).
[145] M. Ambrosio *et al.* [MACRO Collaboration], "Final results of magnetic monopole searches with the MACRO experiment," *Eur. Phys. J. C* **25**, 511 (2002).
[146] E. W. Kolb, S. A. Colgate, and J. A. Harvey, "Monopole catalysis of nucleon decay in neutron stars," *Phys. Rev. Lett.* **49**, 1373 (1982).
[147] S. Dimopoulos, J. Preskill, and F. Wilczek, "Catalyzed nucleon decay in neutron stars," *Phys. Lett.* **119B**, 320 (1982).
[148] K. Freese, M. S. Turner, and D. N. Schramm, "Monopole catalysis of nucleon decay in old pulsars," *Phys. Rev. Lett.* **51**, 1625 (1983).
[149] E. W. Kolb and M. S. Turner, "Limits from the soft X-ray background on the temperature of old neutron stars and on the flux of superheavy magnetic monopoles," *Astrophys. J.* **286**, 702 (1984).
[150] J. A. Harvey, "Monopoles in neutron stars," *Nucl. Phys. B* **236**, 255 (1984).
[151] K. Freese and E. Krasteva, "Bound on the flux of magnetic monopoles from catalysis of nucleon decay in white dwarfs," *Phys. Rev. D* **59**, 063007 (1999).
[152] J. Arafune, M. Fukugita, and S. Yanagita, "Monopole abundance in the Solar System and the intrinsic heat in the Jovian planets," *Phys. Rev. D* **32**, 2586 (1985).
[153] P. Langacker and S.-Y. Pi, "Magnetic monopoles in grand unified theories," *Phys. Rev. Lett.* **45**, 1 (1980).
[154] T. W. B. Kibble and E. J. Weinberg, "When does causality constrain the monopole abundance?," *Phys. Rev. D* **43**, 3188 (1991).
[155] E. J. Weinberg and P. Yi, "Magnetic monopole dynamics, supersymmetry, and duality," *Phys. Rept.* **438**, 65 (2007).
[156] S. Coleman, S. J. Parke, A. Neveu, and C. M. Sommerfield, "Can one dent a dyon?," *Phys. Rev. D* **15**, 544 (1977).
[157] C. H. Taubes, "The existence of a nonminimal solution to the SU(2) Yang–Mills–Higgs equations on R^3. Part I," *Commun. Math. Phys.* **86**, 257 (1982).
[158] C. H. Taubes, "The existence of a nonminimal solution to the SU(2) Yang–Mills–Higgs equations on R^3. Part II," *Commun. Math. Phys.* **86**, 299 (1982).
[159] J. Hong, Y. Kim, and P. Y. Pac, "On the multivortex solutions of the Abelian Chern–Simons–Higgs theory," *Phys. Rev. Lett.* **64**, 2230 (1990).
[160] R. Jackiw and E. J. Weinberg, "Self-dual Chern–Simons vortices," *Phys. Rev. Lett.* **64**, 2234 (1990).
[161] R. Jackiw, K. Lee, and E. J. Weinberg, "Self-dual Chern–Simons solitons," *Phys. Rev. D* **42**, 3488 (1990).
[162] C. Lee, K. Lee, and H. Min, "Self-dual Maxwell–Chern–Simons solitons," *Phys. Lett. B* **252**, 79 (1990).
[163] L. Brink, J. H. Schwarz, and J. Scherk, "Supersymmetric Yang–Mills theories," *Nucl. Phys. B* **121**, 77 (1977).
[164] E. Witten and D. I. Olive, "Supersymmetry algebras that include topological charges," *Phys. Lett.* **78B**, 97 (1978).
[165] C. M. Miller, K. Schalm, and E. J. Weinberg, "Nonextremal black holes are BPS," *Phys. Rev. D* **76**, 044001 (2007).
[166] H. Nastase, M. A. Stephanov, P. van Nieuwenhuizen, and A. Rebhan, "Topological boundary conditions, the BPS bound, and elimination of ambiguities in the quantum mass of solitons," *Nucl. Phys. B* **542**, 471 (1999).
[167] N. Graham and R. L. Jaffe, "Energy, central charge, and the BPS bound for (1+1)-dimensional supersymmetric solitons," *Nucl. Phys. B* **544**, 432 (1999).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016

[168] M. A. Shifman, A. I. Vainshtein, and M. B. Voloshin, "Anomaly and quantum corrections to solitons in two-dimensional theories with minimal supersymmetry," *Phys. Rev.* D **59**, 045016 (1999).
[169] O. Bergman, "Three-pronged strings and 1/4 BPS states in $N = 4$ super-Yang–Mills theory," *Nucl. Phys. B* **525**, 104 (1998).
[170] O. Bergman and B. Kol, "String webs and 1/4 BPS monopoles," *Nucl. Phys. B* **536**, 149 (1998).
[171] K. Lee and P. Yi, "Dyons in $N = 4$ supersymmetric theories and three-pronged strings," *Phys. Rev. D* **58**, 066005 (1998).
[172] W. Nahm, "The construction of all self-dual multimonopoles by the ADHM method." In *Monopoles in Quantum Field Theory*, eds. N. S. Craigie *et al.* (Singapore: World Scientific, 1982).
[173] W. Nahm, "Multimonopoles in the ADHM construction." In *Gauge Theories and Lepton Hadron Interactions*, eds. Z. Horvath *et al.* (Budapest: Central Research Institute for Physics, 1982).
[174] W. Nahm, "All self-dual multimonopoles for arbitrary gauge groups." In *Structural Elements in Particle Physics and Statistical Mechanics*, eds. J. Honerkamp *et al.* (New York: Plenum, 1983).
[175] W. Nahm, "Self-dual monopoles and calorons." In *Group Theoretical Methods in Physics*, eds. G. Denardo *et al.* (Berlin: Springer-Verlag, 1984).
[176] N. Manton and P. Sutcliffe, *Topological Solitons* (Cambridge University Press, 2004).
[177] S. A. Brown, H. Panagopoulos, and M. K. Prasad, "Two separated SU(2) Yang–Mills–Higgs monopoles in the ADHMN Construction," *Phys. Rev. D* **26**, 854 (1982).
[178] P. Houston and L. O'Raifeartaigh, "On the charge distribution of static axial and mirror symmetric monopole systems," *Phys. Lett.* **94B**, 153 (1980).
[179] R. S. Ward, "A Yang–Mills–Higgs monopole of charge 2," *Commun. Math. Phys.* **79**, 317 (1981).
[180] P. Forgacs, Z. Horvath, and L. Palla, "Exact multimonopole solutions in the Bogomolny–Prasad–Sommerfield limit," *Phys. Lett.* **99B**, 232 (1981) [Erratum-ibid. **101**, 457 (1981)].
[181] M. K. Prasad and P. Rossi, "Construction of exact Yang–Mills–Higgs multimonopoles of arbitrary charge," *Phys. Rev. Lett.* **46**, 806 (1981).
[182] C. Rebbi and P. Rossi, "Multimonopole solutions in the Prasad–Sommerfield limit," *Phys. Rev. D* **22**, 2010 (1980).
[183] N. J. Hitchin, N. S. Manton, and M. K. Murray, "Symmetric monopoles," *Nonlinearity* **8**, 661 (1995).
[184] C. J. Houghton and P. M. Sutcliffe, "Tetrahedral and cubic monopoles," *Commun. Math. Phys.* **180**, 343 (1996).
[185] C. J. Houghton and P. M. Sutcliffe, "Monopole scattering with a twist," *Nucl. Phys. B* **464**, 59 (1996).
[186] P. M. Sutcliffe, "Monopole zeros," *Phys. Lett. B* **376**, 103 (1996).
[187] C. J. Houghton and P. M. Sutcliffe, "Octahedral and dodecahedral monopoles," *Nonlinearity* **9**, 385 (1996).
[188] C. J. Houghton, N. S. Manton, and P. M. Sutcliffe, "Rational maps, monopoles and skyrmions," *Nucl. Phys. B* **510**, 507 (1998).
[189] N. S. Manton, "A remark on the scattering of BPS monopoles," *Phys. Lett.* **110B**, 54 (1982).
[190] P. J. Ruback, "Vortex string motion in the Abelian Higgs model," *Nucl. Phys. B* **296**, 669 (1988).
[191] N. S. Manton and T. M. Samols, "Radiation from monopole scattering," *Phys. Lett. B* **215**, 559 (1988).
[192] D. Stuart, "The geodesic approximation for the Yang–Mills–Higgs equations," *Commun. Math. Phys.* **166**, 149 (1994).
[193] N. S. Manton, "Monopole interactions at long range," *Phys. Lett.* **154B**, 397 (1985).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use , available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016

[194] G. W. Gibbons and N. S. Manton, "The moduli space metric for well separated BPS monopoles," *Phys. Lett. B* **356**, 32 (1995).
[195] M. F. Atiyah and N. J. Hitchin, "Low-energy scattering of non-Abelian magnetic monopoles," *Phil. Trans. Roy. Soc. Lond. A* **315**, 459 (1985).
[196] M. F. Atiyah and N. J. Hitchin, "Low-energy scattering of non-Abelian monopoles," *Phys. Lett.* **107A**, 21 (1985).
[197] M. F. Atiyah and N. J. Hitchin, *The Geometry and Dynamics of Magnetic Monopoles* (Princeton University Press, 1988).
[198] G. W. Gibbons and N. S. Manton, "Classical and quantum dynamics of BPS monopoles," *Nucl. Phys. B* **274**, 183 (1986).
[199] E. J. Weinberg, "Fundamental monopoles and multimonopole solutions for arbitrary simple gauge groups," *Nucl. Phys. B* **167**, 500 (1980).
[200] E. J. Weinberg and P. Yi, "Explicit multimonopole solutions in SU(N) gauge theory," *Phys. Rev. D* **58**, 046001 (1998).
[201] S. A. Connell, "The dynamics of the SU(3) charge (1,1) magnetic monopole," University of South Australia preprint (1994).
[202] J. P. Gauntlett and D. A. Lowe, "Dyons and S-duality in $N = 4$ supersymmetric gauge theory," *Nucl. Phys. B* **472**, 194 (1996).
[203] K. Lee, E. J. Weinberg, and P. Yi, "Electromagnetic duality and SU(3) monopoles," *Phys. Lett. B* **376**, 97 (1996).
[204] K. Lee, E. J. Weinberg, and P. Yi, "The moduli space of many BPS monopoles for arbitrary gauge groups," *Phys. Rev. D* **54**, 1633 (1996).
[205] M. K. Murray, "A note on the (1, 1, ..., 1) monopole metric," *J. Geom. Phys.* **23**, 31 (1997).
[206] G. Chalmers, "Multimonopole moduli spaces for SU(N) gauge group," hep-th/9605182 (1996).
[207] C. Lu, "Two monopole systems and the formation of non-Abelian clouds," *Phys. Rev. D* **58**, 125010 (1998).
[208] E. J. Weinberg, "Fundamental monopoles in theories with arbitrary symmetry breaking," *Nucl. Phys. B* **203**, 445 (1982).
[209] K. Lee, E. J. Weinberg, and P. Yi, "Massive and massless monopoles with non-Abelian magnetic charges," *Phys. Rev. D* **54**, 6351 (1996).
[210] E. J. Weinberg, "A continuous family of magnetic monopole solutions," *Phys. Lett.* **119B**, 151 (1982).
[211] R. S. Ward, "Magnetic monopoles with gauge group SU(3) broken to U(2)," *Phys. Lett.* **107B**, 281 (1981).
[212] A. S. Dancer and R. A. Leese, "A numerical study of SU(3) charge-two monopoles with minimal symmetry breaking," *Phys. Lett. B* **390**, 252 (1997).
[213] A. S. Dancer, "Nahm data and SU(3) monopoles," *Nonlinearity* **5**, 1355 (1992).
[214] P. Irwin, "SU(3) monopoles and their fields," *Phys. Rev. D* **56**, 5200 (1997).
[215] C. J. Houghton and E. J. Weinberg, "Multicloud solutions with massless and massive monopoles," *Phys. Rev. D* **66**, 125002 (2002).
[216] A. S. Dancer, "Nahm's equations and hyper-Kähler geometry," *Commun. Math. Phys.* **158**, 545 (1993).
[217] A. Dancer and R. Leese, "Dynamics of SU(3) monopoles," *Proc. Roy. Soc. Lond. A* **440**, 421 (1993).
[218] X. Chen and E. J. Weinberg, "Scattering of massless and massive monopoles in an SU(N) theory," *Phys. Rev. D* **64**, 065010 (2001).
[219] C. M. Miller and E. J. Weinberg, "Interactions of massless monopole clouds," *Phys. Rev. D* **80**, 065025 (2009).
[220] X. Chen, H. Guo, and E. J. Weinberg, "Massless monopoles and the moduli space approximation," *Phys. Rev. D* **64**, 125004 (2001).
[221] C. Montonen and D. I. Olive, "Magnetic monopoles as gauge particles?," *Phys. Lett.* **72B**, 117 (1977).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use , available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016

[222] H. Osborn, "Topological charges for $N = 4$ supersymmetric gauge theories and monopoles of spin 1," *Phys. Lett.* **83B**, 321 (1979).
[223] A. Sen, "Dyon–monopole bound states, self-dual harmonic forms on the multimonopole moduli space, and SL(2,Z) invariance in string theory," *Phys. Lett. B* **329**, 217 (1994).
[224] T. Banks, C. M. Bender, and T. T. Wu, "Coupled anharmonic oscillators. I. Equal-mass case," *Phys. Rev. D* **8**, 3346 (1973).
[225] T. Banks and C. M. Bender, "Coupled anharmonic oscillators. II. Unequal-mass case," *Phys. Rev. D* **8**, 3366 (1973).
[226] S. Coleman, "Fate of the false vacuum: Semiclassical theory," *Phys. Rev. D* **15**, 2929 (1977).
[227] A. A. Belavin, A. M. Polyakov, A. S. Shvarts, and Y. S. Tyupkin, "Pseudoparticle solutions of the Yang–Mills equations," *Phys. Lett.* **59B**, 85 (1975).
[228] S. Coleman, "The uses of instantons." In *Aspects of Symmetry*, S. Coleman (Cambridge University Press, 1985).
[229] J. S. Langer, "Theory of the condensation point," *Annals Phys.* **41**, 108 (1967).
[230] C. G. Callan, Jr. and S. Coleman, "Fate of the false vacuum. II. First quantum corrections," *Phys. Rev. D* **16**, 1762 (1977).
[231] S. Coleman, "Quantum tunneling and negative eigenvalues," *Nucl. Phys. B* **298**, 178 (1988).
[232] R. P. Feynman and A. R. Hibbs, *Quantum Mechanics and Path Integrals* (New York: McGraw-Hill, 1965).
[233] R. Jackiw and C. Rebbi, "Vacuum periodicity in a Yang–Mills quantum theory," *Phys. Rev. Lett.* **37**, 172 (1976).
[234] C. G. Callan, Jr., R. F. Dashen, and D. J. Gross, "The structure of the gauge theory vacuum," *Phys. Lett.* **63B**, 334 (1976).
[235] C. W. Bernard and E. J. Weinberg, "The interpretation of pseudoparticles in physical gauges," *Phys. Rev. D* **15**, 3656 (1977).
[236] V. N. Gribov, "Quantization of non-Abelian gauge theories," *Nucl. Phys. B* **139**, 1 (1978).
[237] R. Jackiw and C. Rebbi, "Conformal properties of a Yang–Mills pseudoparticle," *Phys. Rev. D* **14**, 517 (1976).
[238] G. 't Hooft, "Computation of the quantum effects due to a four-dimensional pseudoparticle," *Phys. Rev. D* **14**, 3432 (1976).
[239] G. 't Hooft, unpublished
[240] R. Jackiw, C. Nohl, and C. Rebbi, "Conformal properties of pseudoparticle configurations," *Phys. Rev. D* **15**, 1642 (1977).
[241] A. S. Schwarz, "On regular solutions of Euclidean Yang–Mills equations," *Phys. Lett.* **67B**, 172 (1977).
[242] R. Jackiw and C. Rebbi, "Degrees of freedom in pseudoparticle systems," *Phys. Lett.* **67B**, 189 (1977).
[243] M. F. Atiyah, N. J. Hitchin, and I. M. Singer, "Deformations of instantons," *Proc. Nat. Acad. Sci.* **74**, 2662 (1977).
[244] L. S. Brown, R. D. Carlitz, and C. Lee, "Massless excitations in instanton fields," *Phys. Rev. D* **16**, 417 (1977).
[245] M. F. Atiyah and I. M. Singer, "The index of elliptic operators. 1," *Annals Math.* **87**, 484 (1968).
[246] M. F. Atiyah, N. J. Hitchin, V. G. Drinfeld, and Y. I. Manin, "Construction of instantons," *Phys. Lett.* **65A**, 185 (1978).
[247] V. G. Drinfeld and Y. I. Manin, "A description of instantons," *Commun. Math. Phys.* **63**, 177 (1978).
[248] N. H. Christ, E. J. Weinberg, and N. K. Stanton, "General self-dual Yang–Mills solutions," *Phys. Rev. D* **18**, 2013 (1978).
[249] E. Corrigan, D. B. Fairlie, S. Templeton, and P. Goddard, "A Green's function for the general self-dual gauge field," *Nucl. Phys. B* **140**, 31 (1978).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016

[250] E. Corrigan and P. Goddard, "Construction of instanton and monopole solutions and reciprocity," *Annals Phys.* **154**, 253 (1984).
[251] E. Witten, "Small instantons in string theory," *Nucl. Phys. B* **460**, 541 (1996).
[252] M. R. Douglas, "Gauge fields and D-branes," *J. Geom. Phys.* **28**, 255 (1998).
[253] A. A. Belavin and A. M. Polyakov, "Quantum fluctuations of pseudoparticles," *Nucl. Phys. B* **123**, 429 (1977).
[254] C. W. Bernard, N. H. Christ, A. H. Guth, and E. J. Weinberg, "Pseudoparticle parameters for arbitrary gauge groups," *Phys. Rev. D* **16**, 2967 (1977).
[255] J. S. Bell and R. Jackiw, "A PCAC puzzle: $\pi_0 \to \gamma\gamma$ in the σ-model," *Nuovo Cim.* **A60**, 47 (1969).
[256] S. L. Adler, "Axial vector vertex in spinor electrodynamics," *Phys. Rev.* **177**, 2426 (1969).
[257] W. A. Bardeen, "Anomalous Ward identities in spinor field theories," *Phys. Rev.* **184**, 1848 (1969).
[258] K. Fujikawa, "Path integral measure for gauge invariant fermion theories," *Phys. Rev. Lett.* **42**, 1195 (1979).
[259] C. G. Callan, Jr., R. F. Dashen, and D. J. Gross, "Toward a theory of the strong interactions," *Phys. Rev. D* **17**, 2717 (1978).
[260] S. Weinberg, "The U(1) problem," *Phys. Rev. D* **11**, 3583 (1975).
[261] G. 't Hooft, "Symmetry breaking through Bell–Jackiw anomalies," *Phys. Rev. Lett.* **37**, 8 (1976).
[262] N. S. Manton, "Topology in the Weinberg–Salam theory," *Phys. Rev. D* **28**, 2019 (1983).
[263] F. R. Klinkhamer and N. S. Manton, "A saddle point solution in the Weinberg–Salam theory," *Phys. Rev. D* **30**, 2212 (1984).
[264] V. A. Rubakov and M. E. Shaposhnikov, "Electroweak baryon number nonconservation in the early universe and in high-energy collisions," *Usp. Fiz. Nauk* **166**, 493 (1996).
[265] K. Nakamura *et al.* [Particle Data Group Collaboration], "Review of particle physics," *J. Phys. G* **37**, 075021 (2010).
[266] R. J. Crewther, P. Di Vecchia, G. Veneziano, and E. Witten, "Chiral estimate of the electric dipole moment of the neutron in quantum chromodynamics," *Phys. Lett.* **88B**, 123 (1979).
[267] R. D. Peccei and H. R. Quinn, "CP conservation in the presence of instantons," *Phys. Rev. Lett.* **38**, 1440 (1977).
[268] R. D. Peccei and H. R. Quinn, "Constraints imposed by CP conservation in the presence of instantons," *Phys. Rev. D* **16**, 1791 (1977).
[269] S. Weinberg, "A new light boson?," *Phys. Rev. Lett.* **40**, 223 (1978).
[270] F. Wilczek, "Problem of strong P and T invariance in the presence of instantons," *Phys. Rev. Lett.* **40**, 279 (1978).
[271] S. Coleman, V. Glaser, and A. Martin, "Action minima among solutions to a class of Euclidean scalar field equations," *Commun. Math. Phys.* **58**, 211 (1978).
[272] A. Kusenko, K. Lee, and E. J. Weinberg, "Vacuum decay and internal symmetries," *Phys. Rev. D* **55**, 4903 (1997).
[273] E. J. Weinberg, "Vacuum decay in theories with symmetry breaking by radiative corrections," *Phys. Rev. D* **47**, 4614 (1993).
[274] I. Affleck, "Quantum statistical metastability," *Phys. Rev. Lett.* **46**, 388 (1981).
[275] A. D. Linde, "Decay of the false vacuum at finite temperature," *Nucl. Phys. B* **216**, 421 (1983).
[276] S. Coleman and F. De Luccia, "Gravitational effects on and of vacuum decay," *Phys. Rev. D* **21**, 3305 (1980).
[277] A. R. Brown and E. J. Weinberg, "Thermal derivation of the Coleman–De Luccia tunneling prescription," *Phys. Rev. D* **76**, 064003 (2007).
[278] G. W. Gibbons and S. W. Hawking, "Cosmological event horizons, thermodynamics, and particle creation," *Phys. Rev. D* **15**, 2738 (1977).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016

[279] G. W. Gibbons and S. W. Hawking, "Action integrals and partition functions in quantum gravity," *Phys. Rev. D* **15**, 2752 (1977).
[280] S. J. Parke, "Gravity, the decay of the false vacuum and the new inflationary universe scenario," *Phys. Lett.* **121B**, 313 (1983).
[281] L. G. Jensen and P. J. Steinhardt, "Bubble nucleation and the Coleman–Weinberg model," *Nucl. Phys. B* **237**, 176 (1984).
[282] L. G. Jensen and P. J. Steinhardt, "Bubble nucleation for flat potential barriers," *Nucl. Phys. B* **317**, 693 (1989).
[283] J. C. Hackworth and E. J. Weinberg, "Oscillating bounce solutions and vacuum tunneling in de Sitter spacetime," *Phys. Rev. D* **71**, 044014 (2005).
[284] P. Batra and M. Kleban, "Transitions between de Sitter minima," *Phys. Rev. D* **76**, 103510 (2007).
[285] T. Banks, "Heretics of the false vacuum: Gravitational effects on and of vacuum decay. 2," hep-th/0211160 (2002).
[286] S. W. Hawking and I. G. Moss, "Supercooled phase transitions in the very early universe," *Phys. Lett.* **110B**, 35 (1982).
[287] K. Lee and E. J. Weinberg, "Decay of the true vacuum in curved space-time," *Phys. Rev. D* **36**, 1088 (1987).
[288] L. F. Abbott and S. Deser, "Stability of gravity with a cosmological constant," *Nucl. Phys. B* **195**, 76 (1982).
[289] J. C. Hackworth, "Vacuum decay in de Sitter spacetime," Ph. D. thesis, Columbia University (2006).
[290] G. Lavrelashvili, "The number of negative modes of the oscillating bounces," *Phys. Rev. D* **73**, 083513 (2006).
[291] T. Tanaka, "The no-negative mode theorem in false vacuum decay with gravity," *Nucl. Phys. B* **556**, 373 (1999).
[292] A. Khvedelidze, G. V. Lavrelashvili, and T. Tanaka, "On cosmological perturbations in closed FRW model with scalar field and false vacuum decay," *Phys. Rev. D* **62**, 083501 (2000).
[293] G. V. Lavrelashvili, "Negative mode problem in false vacuum decay with gravity," Nucl. Phys. Proc. Suppl. **88**, 75 (2000).
[294] S. Gratton and N. Turok, "Homogeneous modes of cosmological instantons," *Phys. Rev. D* **63**, 123514 (2001).
[295] S. Coleman and P. J. Steinhardt, unpublished.
[296] A. A. Starobinsky, "Stochastic de Sitter (inflationary) stage in the early universe." In *Field Theory, Quantum Gravity and Strings*, eds. H. J. De Vega and N. Sanchez (New York: Springer-Verlag, 1986).
[297] A. S. Goncharov, A. D. Linde, and V. F. Mukhanov, "The global structure of the inflationary universe," *Int. J. Mod. Phys. A* **2**, 561 (1987).
[298] A. D. Linde, "Hard art of the universe creation (stochastic approach to tunneling and baby universe formation)," *Nucl. Phys. B* **372**, 421 (1992).
[299] A. D. Linde, "A new inflationary universe scenario: A possible solution of the horizon, flatness, homogeneity, isotropy and primordial monopole problems," *Phys. Lett.* **108B**, 389 (1982).
[300] A. Albrecht and P. J. Steinhardt, "Cosmology for grand unified theories with radiatively induced symmetry breaking," *Phys. Rev. Lett.* **48**, 1220 (1982).
[301] J. Garriga and A. Megevand, "Coincident brane nucleation and the neutralization of Λ," *Phys. Rev. D* **69**, 083510 (2004).
[302] A. Masoumi and E. J. Weinberg, "Bounces with O(3)×O(2) symmetry." (2012).
[303] S. W. Hawking, I. G. Moss, and J. M. Stewart, "Bubble collisions in the very early universe," *Phys. Rev. D* **26**, 2681 (1982).
[304] J. Garriga, A. H. Guth, and A. Vilenkin, "Eternal inflation, bubble collisions, and the persistence of memory," *Phys. Rev. D* **76**, 123512 (2007).
[305] S. Chang, M. Kleban, and T. S. Levi, "When worlds collide," *JCAP* **0804**, 034 (2008).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016

[306] S. Chang, M. Kleban, and T. S. Levi, "Watching worlds collide: Effects on the CMB from cosmological bubble collisions," *JCAP* **0904**, 025 (2009).
[307] A. Aguirre, M. C. Johnson, and M. Tysanner, "Surviving the crash: Assessing the aftermath of cosmic bubble collisions," *Phys. Rev. D* **79**, 123514 (2009).
[308] B. Freivogel, M. Kleban, A. Nicolis, and K. Sigurdson, "Eternal inflation, bubble collisions, and the disintegration of the persistence of memory," *JCAP* **0908**, 036 (2009).
[309] J. J. Blanco-Pillado and M. P. Salem, "Observable effects of anisotropic bubble nucleation," *JCAP* **1007**, 007 (2010).
[310] L. F. Abbott and S. Coleman, "The collapse of an anti-de Sitter bubble," *Nucl. Phys. B* **259**, 170 (1985).
[311] J. E. Humphreys, *Introduction to Lie Algebras and Representation Theory* (New York: Springer-Verlag, 1972).
[312] P. Ramond, *Group Theory* (Cambridge University Press, 2010).
[313] H. J. de Vega and F. A. Schaposnik, "Classical vortex solution of the Abelian Higgs model," *Phys. Rev. D* **14**, 1100 (1976).
[314] J. E. Kiskis, "Fermions in a pseudoparticle field," *Phys. Rev. D* **15**, 2329 (1977).

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 14 Nov 2026 at 06:21:58, subject to the Cambridge Core terms of use , available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9781139017787.016