

SINGLE POINT BLOW-UP SOLUTIONS TO THE HEAT EQUATION WITH NONLINEAR BOUNDARY CONDITIONS

JUNICHI HARADA

Abstract. We study finite blow-up solutions of the heat equation with nonlinear boundary conditions. We provide a sufficient condition for the single point blow-up at the origin and a precise spacial singularity of the blow-up profile.

Mathematics subject classification (2010): 35K20, 35B44.

Keywords and phrases: blow-up, nonlinear boundary condition.

REFERENCES

- [1] M. ABRAMOWITZ, I. A. STEGUN, *Handbook of Mathematical Functions with Formulas, Graphs and Mathematical Tables*, Dover Publications, INC., New York, 1965.
- [2] D. AMADORI, *Unstable blow-up patterns*, *Differential Integral Equations*, **8**, 8 (1995), 1977–1996.
- [3] J. BRICMONT, A. KUPIAINEN, *Universality in blow-up for nonlinear heat equations*, *Nonlinearity*, **7**, 2 (1994), 539–575.
- [4] X. -Y. CHEN, H. MATANO, *Convergence, asymptotic periodicity, and finite-point blow-up in one-dimensional semilinear heat equations*, *J. Differential Equations*, **78**, 1 (1989), 160–190.
- [5] M. CHLEBIK, M. FILA, *On the blow-up rate for the heat equation with a nonlinear boundary condition*, *Math. Methods Appl. Sci.*, **23**, 15 (2000), 1323–2330.
- [6] M. CHLEBIK, M. FILA, *Some recent results on blow-up on the boundary for the heat equation*, *Evolution equations: existence, regularity and singularities*, *Banach Center Publ.*, **52** (2000), 61–71.
- [7] S. DEJAK, Z. GANG, I. M. SIGAL, S. WANG, *Blow-up in nonlinear heat equations*, *Adv. in Appl. Math.*, **40**, 4 (2008), 433–481.
- [8] K. DENG, M. FILA, H. A. LEVINE, *On critical exponents for a system of heat equations coupled in the boundary conditions*, *Acta Math. Univ. Comenian.*, bf 63 (1994) 169–192.
- [9] M. FILA, P. QUITTNER, *The blowup rate for the heat equation with a nonlinear boundary condition*, *Math. Meth. in Appl. Sci.*, **14** (1991), 197–205.
- [10] Y. GIGA, R. KOHN, *Nondegeneracy of blowup for semilinear heat equations*, *Comm. Pure Appl. Math.*, **42** (1989), 845–884.
- [11] C. FERMANIAN KAMMERER, F. MERLE, H. ZAGG, *Stability of the blow-up profile of non-linear heat equations from the dynamical system point of view*, *Math. Ann.*, **317**, 2 (2000), 347–387.
- [12] A. FRIEDMAN, B. MCLEOD, *Blow-up of positive solutions of semilinear heat equations*, *Indiana Univ. Math. J.*, **34** (1985), 425–447.
- [13] J. HARADA, *Blow-up behavior of solutions to the heat equation with nonlinear boundary conditions*, preprint.
- [14] M. A. HERRERO, J. J. L. VELÁZQUEZ, *Flat blow-up in one-dimensional semilinear heat equations*, *Differential Integral Equations*, **5**, 5 (1992), 973–997.
- [15] M. A. HERRERO, J. J. L. VELÁZQUEZ, *Blow-up profiles in one-dimensional semilinear parabolic problems*, *Comm. Partial Differential Equations*, **17**, 1-2 (1992), 205–219.
- [16] M. A. HERRERO, J. J. L. VELÁZQUEZ, *Blow-up behavior of one-dimensional semilinear parabolic equations*, *Ann. Inst. Henri Poincaré*, **10**, 2 (1993), 131–189.
- [17] S. HITOMATSU, S. MORIGUCHI, K. UDAGAWA, *Mathematical Formula III*, Iwanamishoten, 1987 (in Japanese).

- [18] B. HU, *Nondegeneracy and single-point-blowup for solution of the heat equation with a nonlinear boundary condition*, J. Math. Sci. Univ. Tokyo, **1**, 2 (1994), 251–276.
- [19] B. HU, H. -M. YIN, *The profile near blowup time for solution of the heat equation with a nonlinear boundary condition*, Trans. Am. Math. Soc., **346** (1994), 117–135.
- [20] F. MERLE, *Solution of a nonlinear heat equation with arbitrarily given blow-up points*, Comm. Pure Appl. Math., **45**, 3 (1992), 263–300.
- [21] F. MERLE, H. ZAGG, *Stability of the blow-up profile for equations of the type $u_t = \Delta u + |u|^{p-1}u$* , Duke Math. J., **86**, 1 (1997) 143–195.
- [22] F. MERLE, H. ZAGG, *Refined uniform estimates at blow-up and application for nonlinear heat equations*, Geom. Funct. Anal., **8**, 6 (1998), 1043–1085.
- [23] J. J. L. VELÁZQUEZ, *Higher dimensional blow up for semilinear parabolic equations*, Commun. in Partial Differential Equations, **17**, 9-10 (1992), 1567–1596.