ON NON-NORMALIZED SUBORDINATION CHAINS IN \mathbb{C}^n

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Abstract. In this paper we consider non-normalized univalent subordination chains $f(z,t) = \exp(\int_0^t A(\tau) d\tau) z + \cdots$ and we present the connection with the notion of generalized A-asymptotic spirallikeness on the Euclidean unit ball B^n in \mathbb{C}^n , where $A : [0, \infty) \to L(\mathbb{C}^n, \mathbb{C}^n)$ is a measurable operator that satisfies certain natural conditions.

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Key words. Biholomorphic mapping, generalized asymptotic spirallike mapping, Loewner differential equation, subordination, subordination chain.

REFERENCES

- BRACCI, F., CONTRERAS, M.D. and MADRIGAL, S.D., Evolution families and the Loewner equation II: complex hyperbolic manifolds, Math. Ann., 344 (2009), 947–962.
- [2] DALECKII, YU. and KREIN, M.G., Stability of Solutions of Differential Equations in Banach Space, Translations of Mathematical Monographs, 43, Amer. Math. Soc., 1974.
- [3] DUREN, P., GRAHAM, I., HAMADA, H. and KOHR, G., Solutions for the generalized Loewner differential equation in several complex variables, Math. Ann., 347 (2010), 411–435.
- [4] ELIN, M., REICH, S. and SHOIKHET, D., Complex dynamical systems and the geometry of domains in Banach spaces, Dissertationes Math., 427 (2004), 1–62.
- [5] GONG, S., Convex and Starlike Mappings in Several Complex Variables, Kluwer Acad. Publ., Dordrecht, 1998.
- [6] GRAHAM, I., HAMADA, H. and KOHR, G., Parametric representation of univalent mappings in several complex variables, Canad. J. Math., 54 (2002), 324–351.
- [7] GRAHAM, I., HAMADA, H., KOHR, G. and KOHR, M., Parametric representation and asymptotic starlikeness in Cⁿ, Proc. Amer. Math. Soc., **136** (2008), 3963–3973.
- [8] GRAHAM, I., HAMADA, H., KOHR, G. and KOHR, M., Asymptotically spirallike mappings in several complex variables, J. Anal. Math., 105 (2008), 267–302.
- [9] GRAHAM, I., HAMADA, H., KOHR, G. and KOHR, M., Spirallike mappings and univalent subordination chains in Cⁿ, Ann. Sc. Norm. Super. Pisa Cl. Sci. (5), 7 (2008), 717–740.
- [10] GRAHAM, I. and KOHR, G., Geometric Function Theory in One and Higher Dimensions, Marcel Dekker, New York, 2003.
- [11] GRAHAM, I., KOHR, G. and KOHR, M., Loewner chains and parametric representation in several complex variables, J. Math. Anal. Appl., 281 (2003), 425–438.

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- [12] GURGANUS, K., Φ-like holomorphic functions in Cⁿ and Banach spaces, Trans. Amer. Math. Soc., **205** (1975), 389–406.
- [13] HAMADA, H. and KOHR, G., Subordination chains and the growth theorem of spirallike mappings, Mathematica, 42 (65) (2000), 155–163.
- [14] HAMADA, H. and KOHR, G., An estimate of the growth of spirallike mappings relative to a diagonal matrix, Ann. Univ. Mariae Curie-Sklodowska Sect. A, 55 (2001), 53–59.
- [15] HAMADA, H. and KOHR, G., The growth theorem and quasiconformal extension of strongly spirallike mappings of type α, Complex Var. Elliptic Equ., 44 (2001), 281– 297.
- [16] HAMADA, H. and KOHR, G., Φ-like and convex mappings in infinite dimensional spaces, Rev. Roumaine Math. Pures Appl., 47 (2002), 315–328.
- [17] PFALTZGRAFF, J.A., Subordination chains and univalence of holomorphic mappings in \mathbb{C}^n , Math. Ann., **210** (1974), 55–68.
- [18] POMMERENKE, C., Über die Subordination analytischer Funktionen, J. Reine Angew. Math., 218 (1965), 159–173.
- [19] POMMERENKE, C., Univalent Functions, Vandenhoeck & Ruprecht, Göttingen, 1975.
- [20] POREDA, T., On the univalent holomorphic maps of the unit polydisc in Cⁿ which have the parametric representation, I - the geometrical properties, Ann. Univ. Mariae Curie-Sklodowska Sect. A, 41 (1987), 105–113.
- [21] POREDA, T., On the univalent holomorphic maps of the unit polydisc in \mathbb{C}^n which have the parametric representation, II the necessary conditions and the sufficient conditions, Ann. Univ. Mariae Curie-Sklodowska Sect. A, **41** (1987), 115–121.
- [22] POREDA, T., On generalized differential equations in Banach spaces, Dissertationes Math., 310 (1991), 1–50.
- [23] POREDA, T. and SZADKOWSKA, A., On the holomorphic solutions of certain differential equations of first order for the mappings of the unit ball in \mathbb{C}^n into \mathbb{C}^n , Demonstratio Math., **22** (1989), 983–996.
- [24] REICH, S. and SHOIKHET, D., Nonlinear Semigroups, Fixed Points, and Geometry of Domains in Banach Spaces, Imperial College Press, London, 2005.
- [25] SUFFRIDGE, T.J., Starlikeness, convexity and other geometric properties of holomorphic maps in higher dimensions, Lecture Notes in Math., 599 (1977), 146–159, Springer-Verlag.

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