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Global Dynamics of a System Coming from the Study of a Static Star

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Abstract
We classify the global dynamics of a one-parameter family of planar quadratic polynomial differential systems which for some interval of values of its parameter describes the evolution of a static star. The characterization of their distinct topological phase portraits is done in the Poincaré disc. In this way we can describe the dynamics of these systems near infinity and to provide their global phase portrait.

Keywords Phase portraits · Global dynamics · Poincaré compactification · Static star

Mathematics Subject Classification 34C05

Introduction and statement of the main results

The structure equations using geometrical units for a static star in general relativity are

$$\frac{dM}{dr} = 4\pi r^2 \rho \tag{1}$$

and

$$\frac{dP}{dr} = -\frac{(\rho + P)(M + 4\pi r^3 P)}{r^2(1 - 2M/r)}, \tag{2}$$

where $M(r)$ is the mass of the star inside a sphere of radius r from the center of mass satisfying $M(r) \geq 0$ for all $r \geq 0$, and $M(r) \to 0$ as $r \to 0$, r is the distance to the center of mass

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