

SIDE 14.2



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Classification of 3d Dupin Cyclidic Coordinates

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Content :

Dupin cyclidic (DC) coordinates in $\mathbb{R}^3$ are triple orthogonal coordinates where all coordinate lines are circles or straight lines. Besides classical examples (spherical, cylindrical, conical, etc.) there are less-known DC coordinates constructed using two focal conics (ellipse and hyperbola, or two parabolas) in orthogonal planes, used by Darboux for separation of variables in the Laplace equation (see details in [1]).

We classify all possible DC coordinates up to conformal transformations of $\mathbb{R}^3$. It appears that most general DC coordinates can be reduced to the canonical form where their singular set Sing is a union of up to 3 bicircular quartic curves on separate orthogonal planes. Such an arrangement of curves had already appeared in Darboux's book [2, p. 472] in the context of different coordinates (with coordinate lines definitely distinct from circles).

The full conformal classification of DC coordinates contains two big 2-parameter classes (with 3 and 2 orthogonal planes as coordinate surfaces) that are uniquely defined by their Sing sets and 1-parameter class, generated by offsets of a rotational cone.

[1] A. Sym, and A. Szereszewski, On Darboux's Approach to R-Separability of Variables, SIGMA 7 (2011).

[2] G. Darboux, Principes de Géométrie Analytique, Gauthier-Villars, Paris 1917.

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