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The maximum turnaround radius of non-spherical cosmic structures. (English)
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Summary: Three simple idealised models are studied in order to develop some intuition about the leading order effect of non-sphericity on the maximum turnaround size $R_{TA,\text{max}}$ of large scale bound cosmic structures. Two of them describe intrinsically axisymmetric static mass distributions whereas the other is the Kerr-de Sitter metric where the axisymmetry is generated due to the rotation of the structure. In all the cases the fractional change $\delta R_{TA,\text{max}}(\theta)/R_{TA,\text{max}}^{(0)}$ of $R_{TA,\text{max}}$ of a given structure, compared to a spherical one with the same mass $M$, depends on the polar angle $\theta$ and is proportional to the product of the relevant eccentricity parameter, times the square of a small quantity. This quantity in the static examples is the ratio of two characteristic length scales, while in the spinning case it is the ratio $v_{\text{out}}/c$ of the azimuthal speed of the outmost members of the structure, over the speed of light. Furthermore, the angular average $\langle \delta R_{TA,\text{max}}(\theta)/R_{TA,\text{max}}^{(0)} \rangle$ is zero in the two static cases, while it is negative and proportional to $O(v_{\text{out}}^2/c^2)$ for the Kerr-de Sitter. Thus, $\delta R_{TA,\text{max}}(\theta)/R_{TA,\text{max}}^{(0)}$ for an axisymmetric structure is very small for practically any value of the eccentricity parameter. We speculate about some possible further implications of our result on the maximum turn around radius of realistic cosmic structures.

MSC:
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83F05 Relativistic cosmology
85A40 Astrophysical cosmology

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References: