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TORUS-LIKE BALLOONS

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Abstract. The concepts for inflatable deployable structures have been under development and evaluation for many years. Strangely enough only the Mylar balloon up to now has been described adequately. Here we provide the mathematical model and its analytical solution for the torus-like balloons. Their characteristics and shapes are described explicitly in terms of elliptic integrals. The obtained results are commented shortly and the possible directions for the related studies in the future are outlined.

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1. Introduction

It is quite easy to describe the stage behind the title of the present paper. The torus-like balloons are constructed by taking two identical annular disks, sewing them along their boundaries and then inflating with either air or helium.
This setting is similar to that of the so called Mylar balloon which is well documented [2, 6, 7, 9–12].
To some surprise the geometry of the torus balloons has not been studied yet despite of their numerous practical applications as automobile tires, swimming rings, doughnuts, just to mention a few of them. Thus, this situation suggests the following mathematical problem: Given two annular disks with holes of internal radius r and width a – what will be the shape of the balloon made by them when it is inflated?
Eventually, besides answering this question one will be definitely interested also at least in the following questions:

i) what is the external radius of the inflated balloon?

ii) what is the maximal thickness of the inflated balloon?

In what follows we will answer the above questions and add some comments about the effective reconstruction of these balloons.