

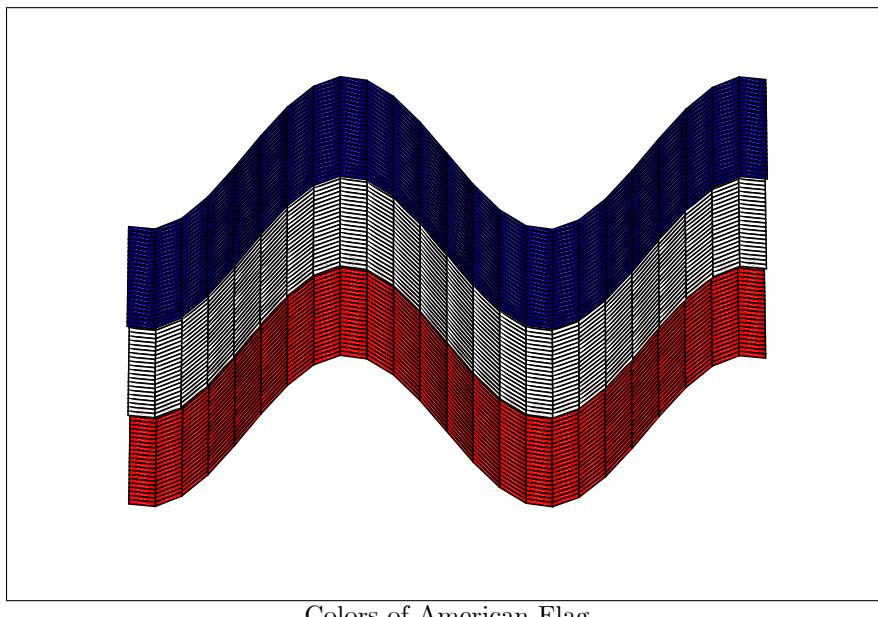
HYPER SYMMETRIES

By

Dejenie A. Lakew

Virginia State University
Department of Mathematics & Computer Science
Petersburg, Virginia

The usual elementary functions can generate sophisticated graphs which are shown below. These graphs are surfaces, superpositions of surfaces and rotations of them. They are obtained by using different coordinate systems, such as the Cartesian, cylindrical or spherical. For instance the three colors of the American flag drawn below is the superimpositions of surfaces obtained by the trigonometric surface : $z = 6 \cos x$ shown in Fig.1 and its translates and few rotations in Cartesian coordinate system of \mathbb{R}^3



Colors of American Flag

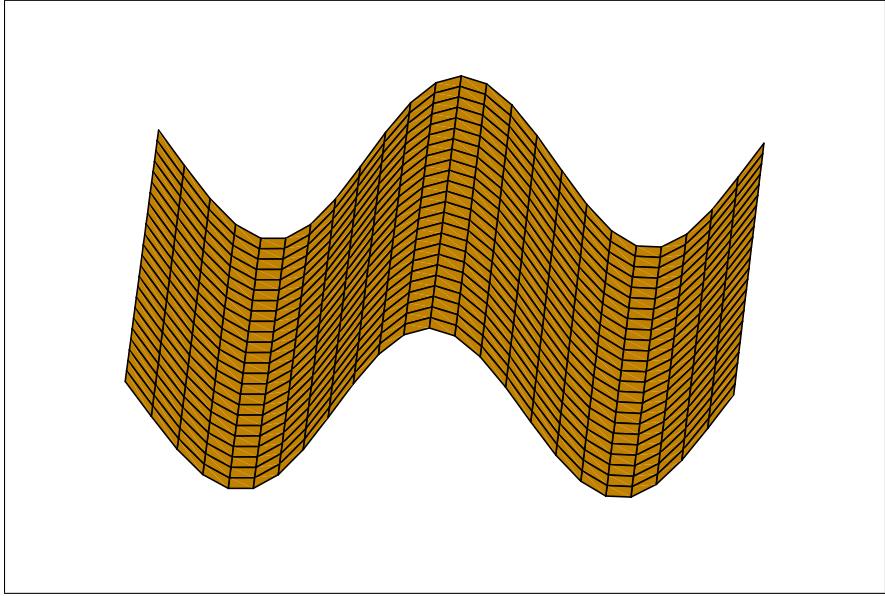
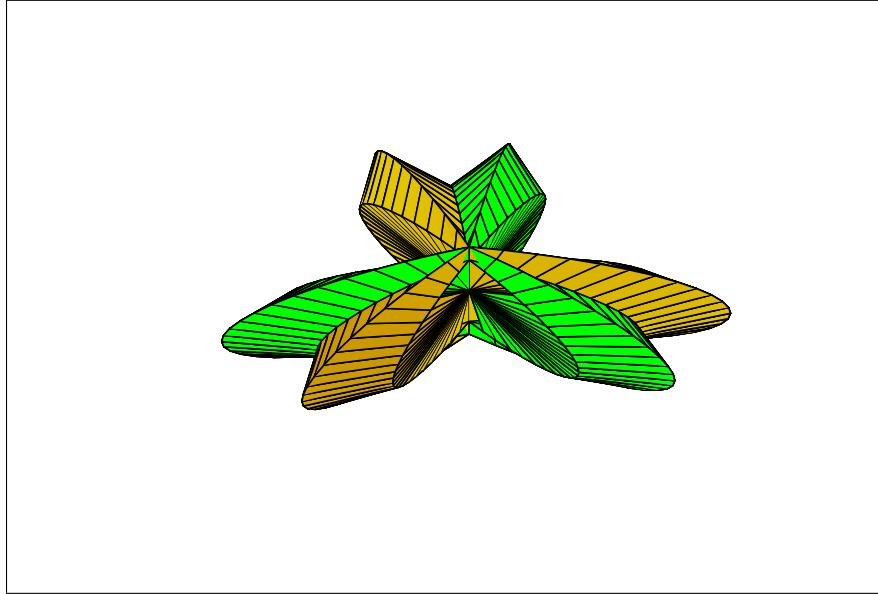


Fig. 1

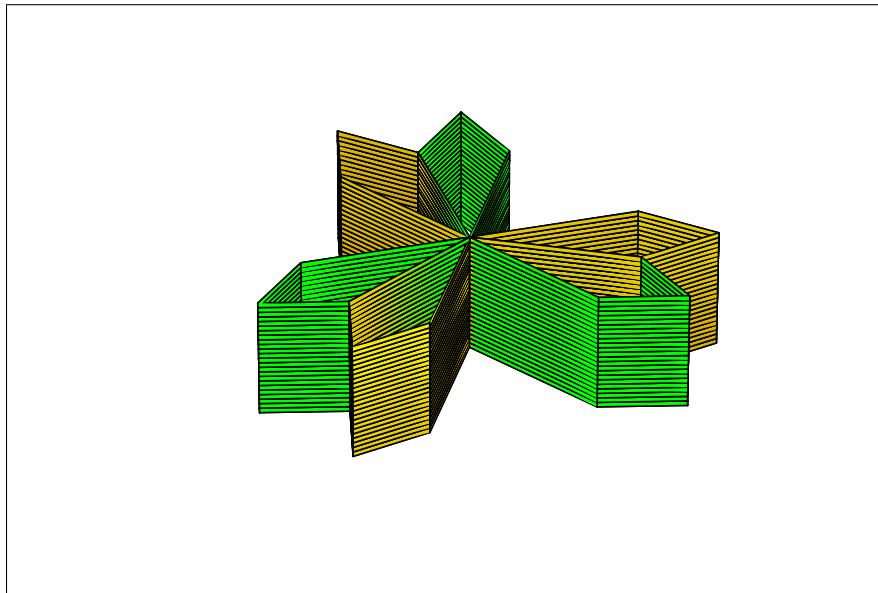
Let us consider the trigonometric function $\rho = \sin 3\theta$ (graph in golden). We know that its graph in polar coordinates in the $2 - D$ space \mathbb{R}^2 is a curve with three petals or leaves. superimpose its normalized derivative $\rho'_n = \cos 3\theta$ (graph in green) on the same coordinate system and get the following :

When we look at the family of surfaces whose traces are curves of the above types in spherical coordinate system of \mathbb{R}^3 , with some rotations, we get superimposed surfaces shown below:



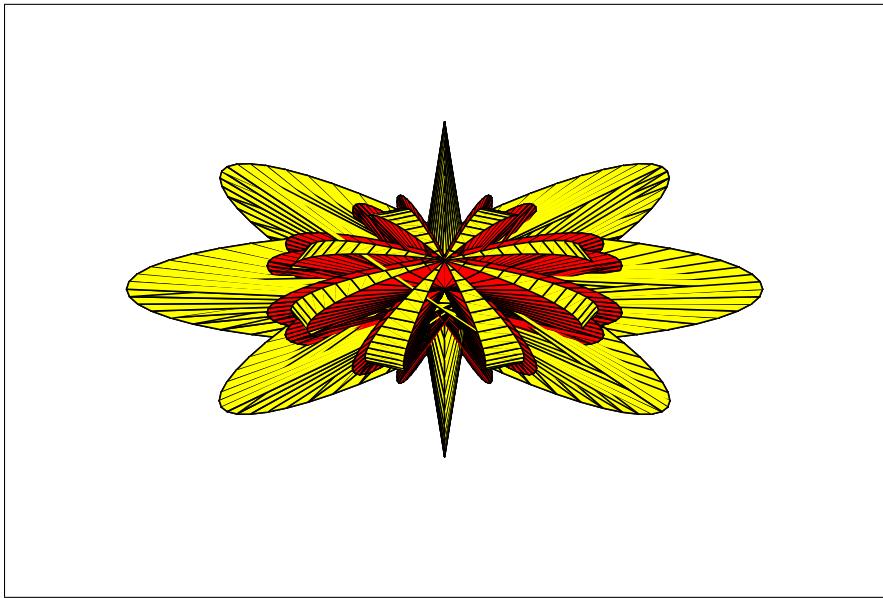
Dej. 97

Again when we plot the family of surfaces of the same traces of curves in cylindrical coordinates followed by some rotations, we get :



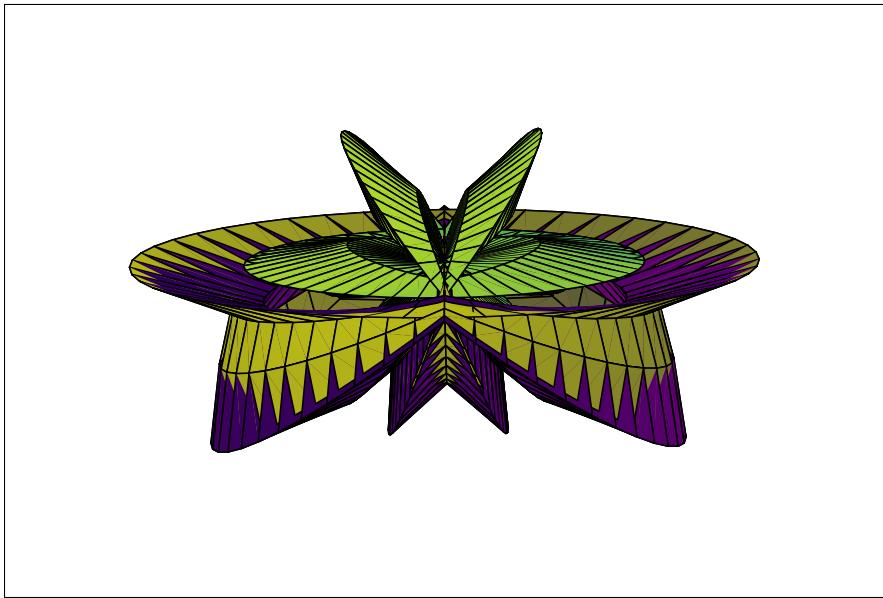
Dej. 96

The superimposition of the trigonometric surfaces : $\rho = 2 \sin 8\theta$ and $\delta = 3 \cos 8\theta$ followed with some rotations will provide the following star structure:



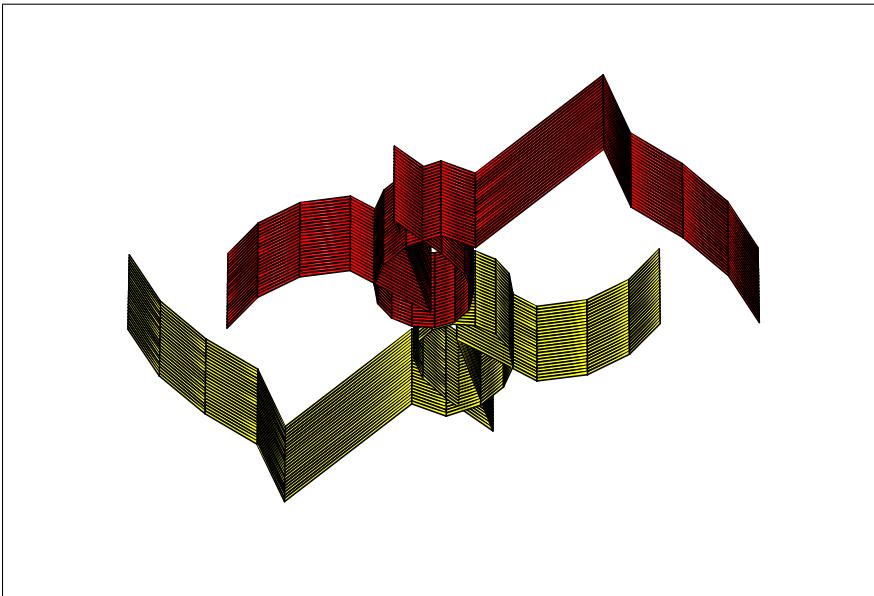
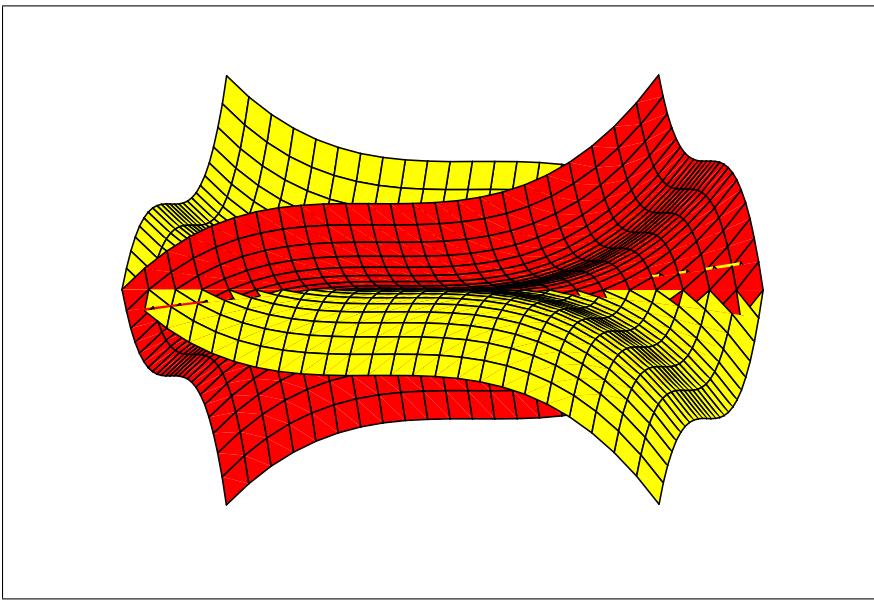
Dej. 95

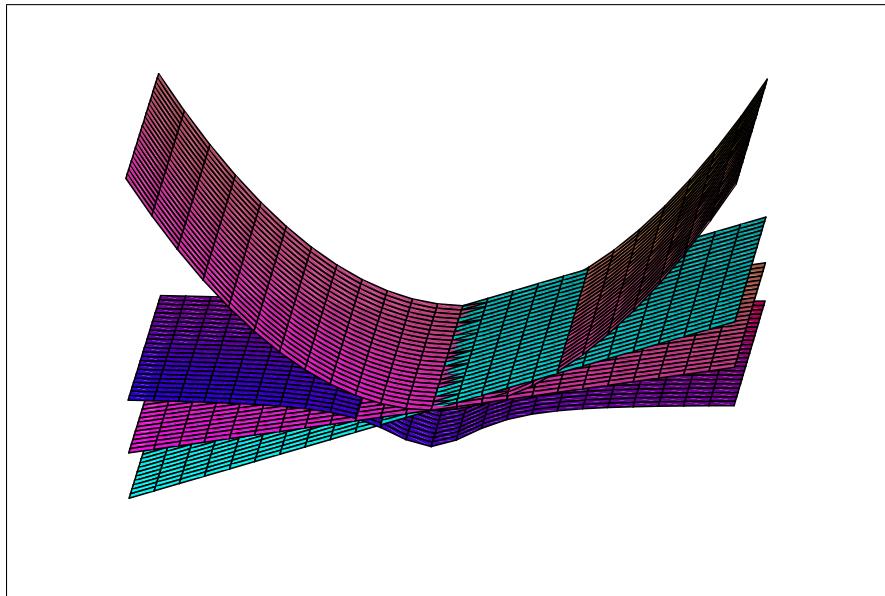
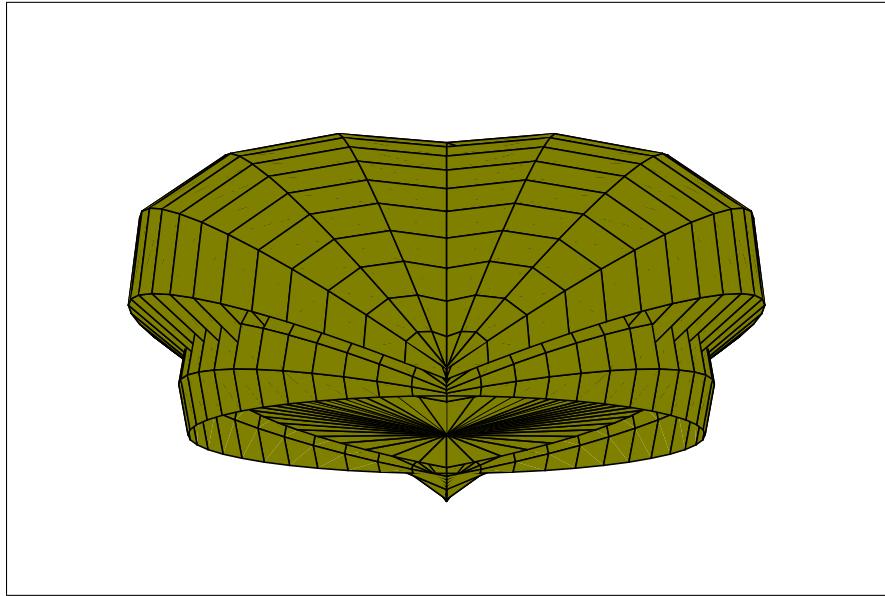
In a similar way the superimpositions with some rotations of surfaces generated from: $\rho = \sin 6\theta + \theta$, $\sigma = \frac{2}{3} \sin 6(\theta - \pi) + \theta$ and $\beta = \cos 6\theta + 1$ give the picture:

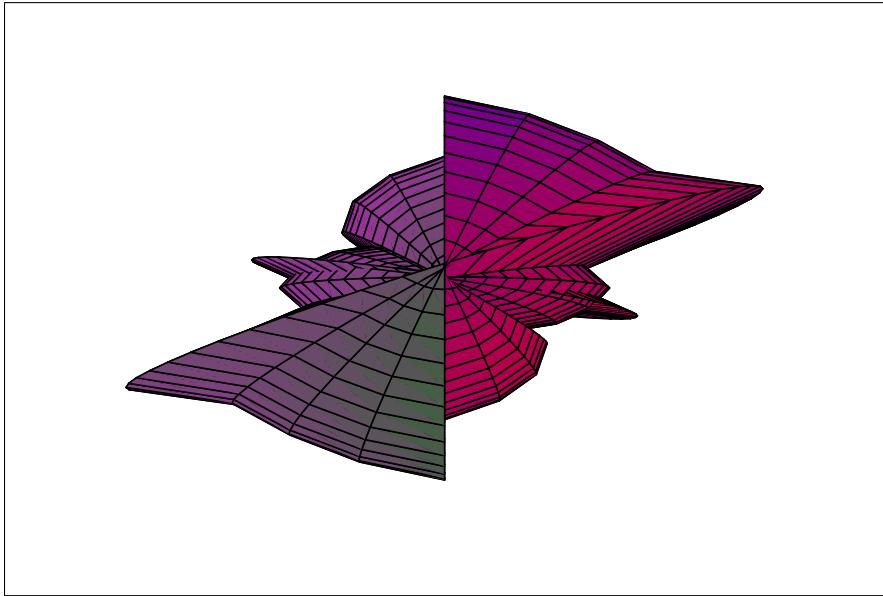
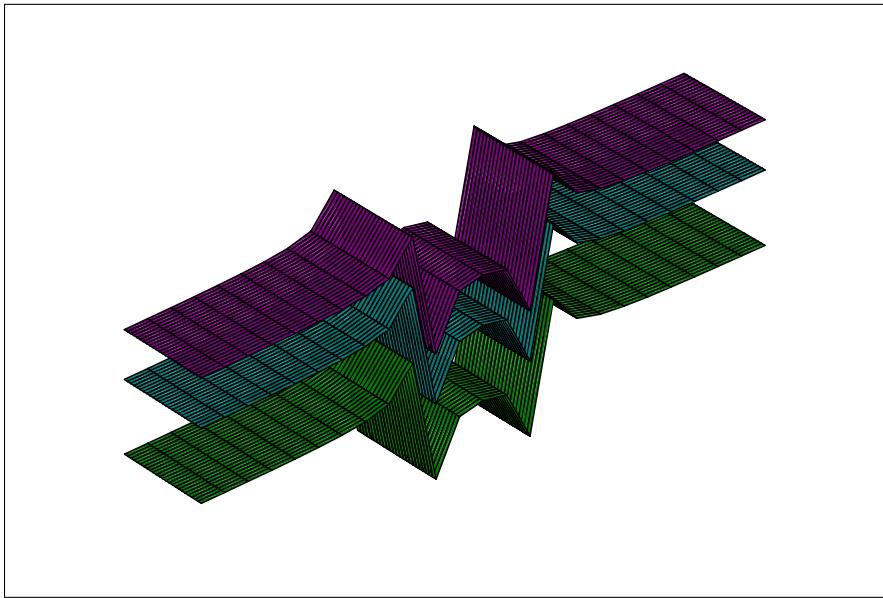


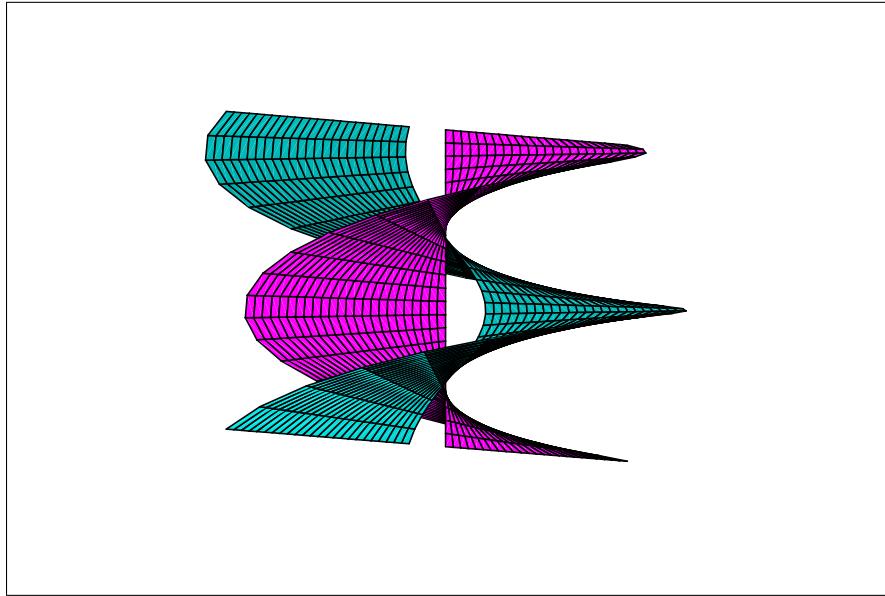
Dej. 94

All the graphs are therefore generated in similar methods.

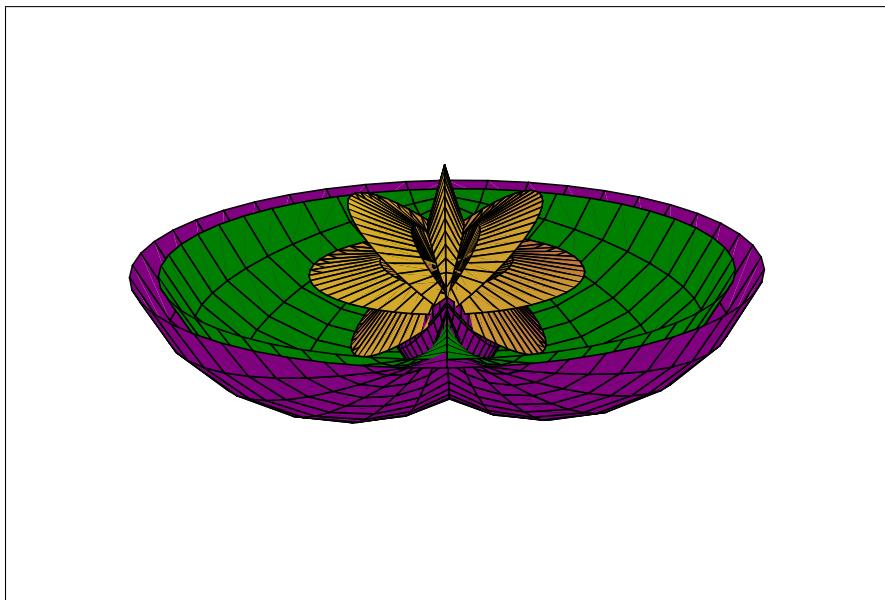




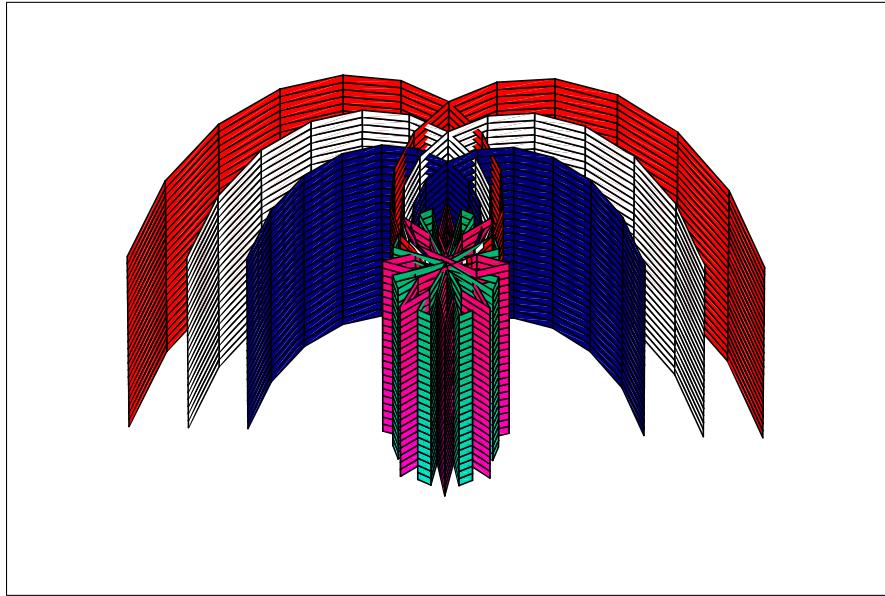




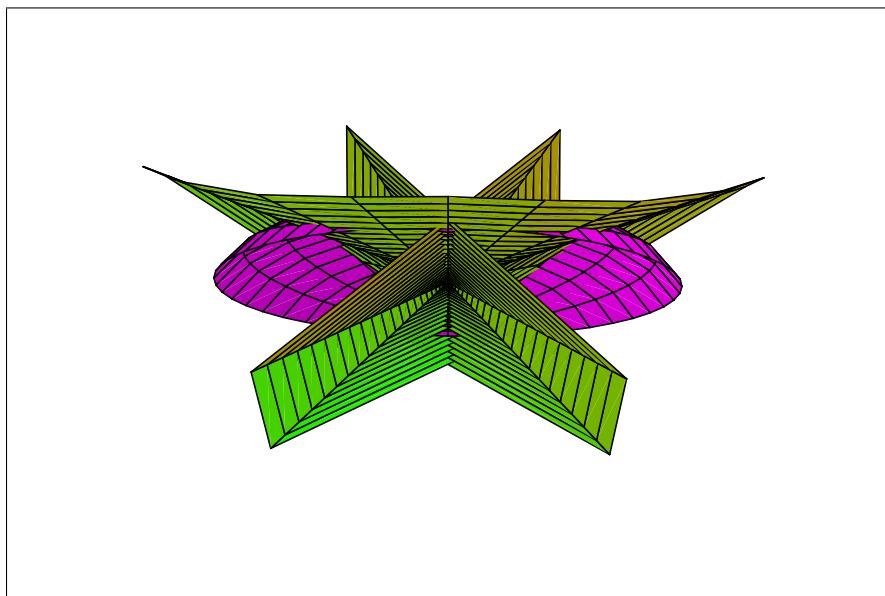
Dej. 93



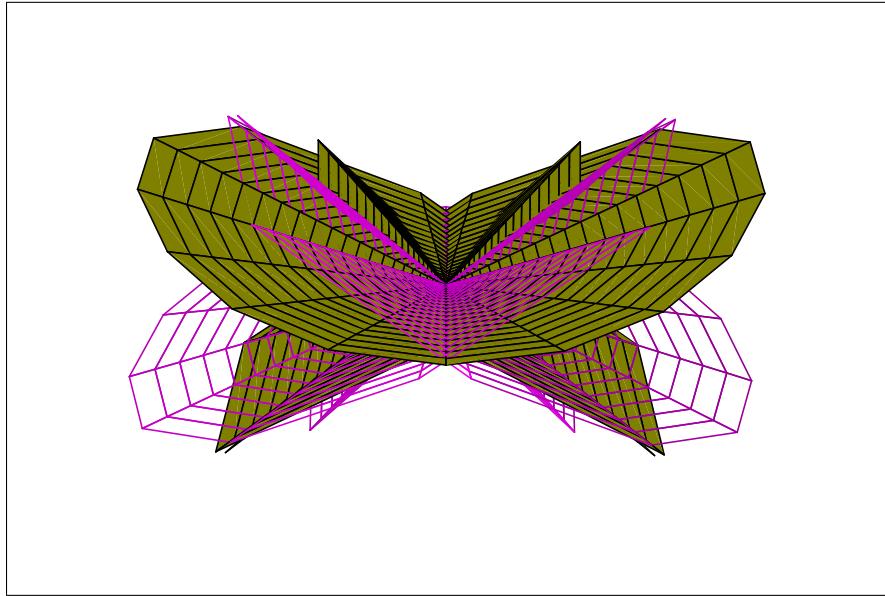
Dej. 92



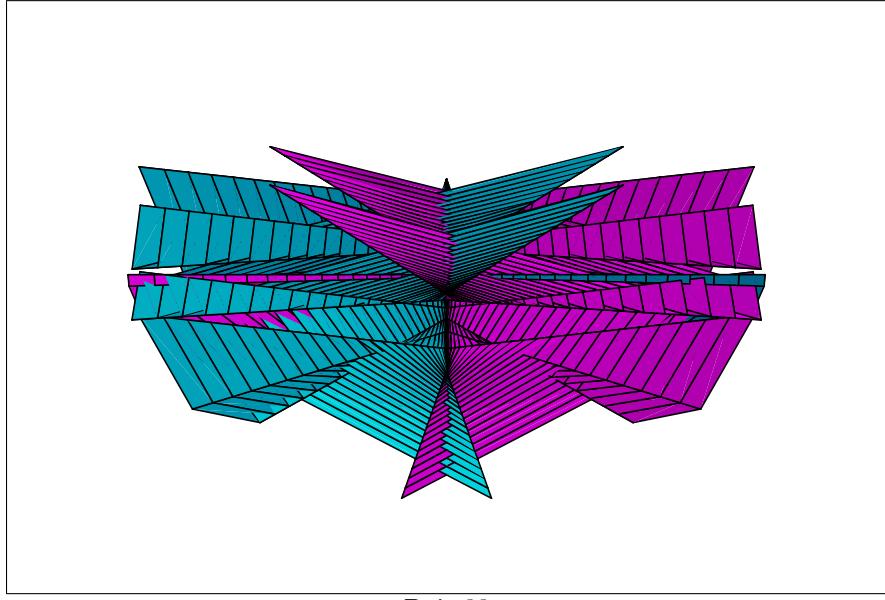
Dej. 91



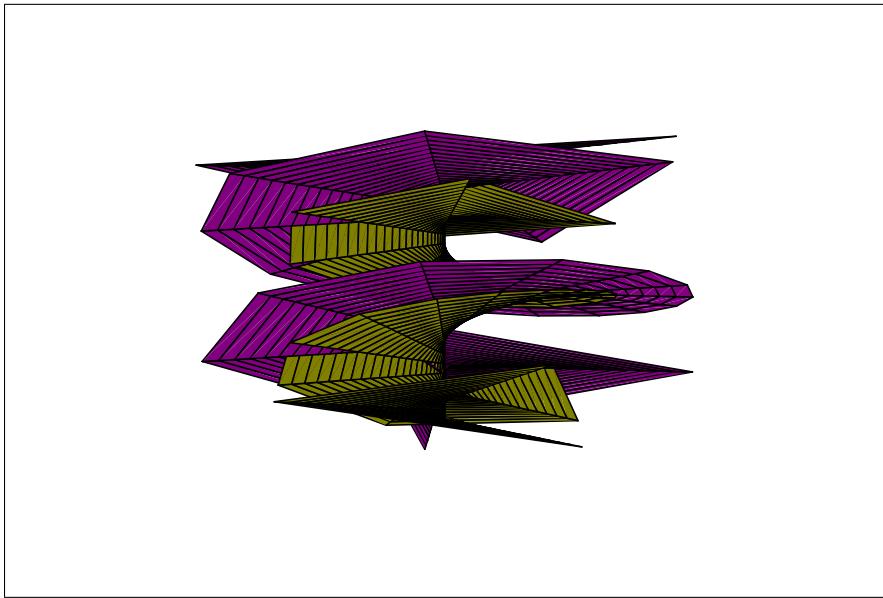
Dej. 90



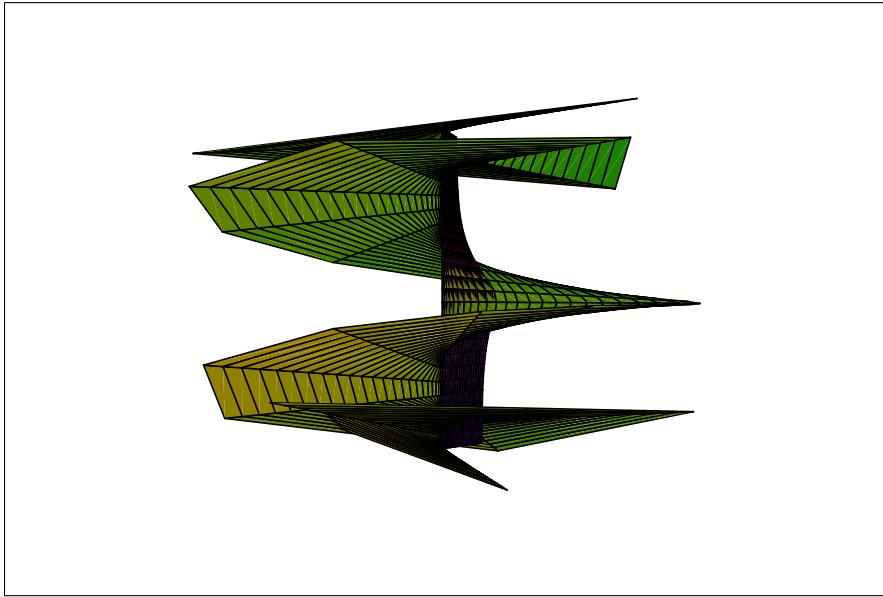
Dej. 89



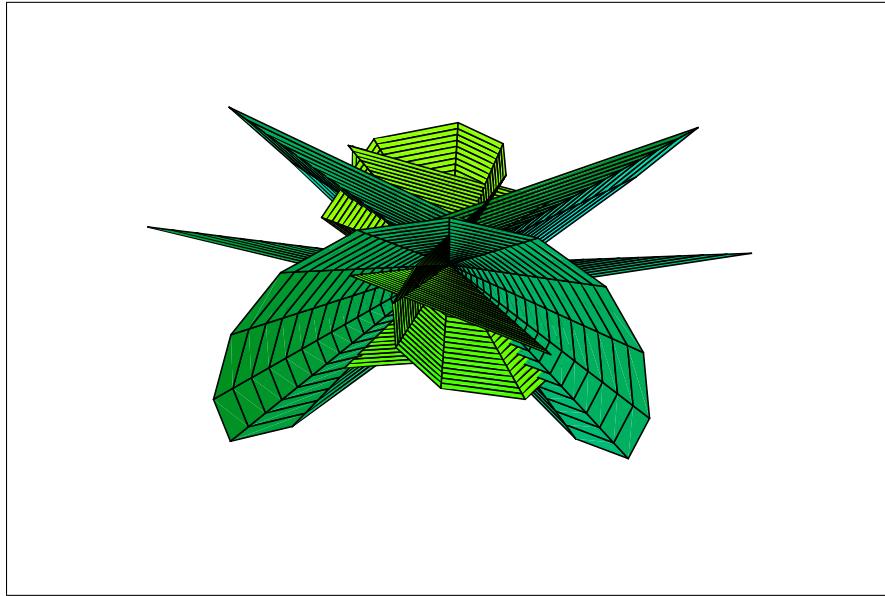
Dej. 88



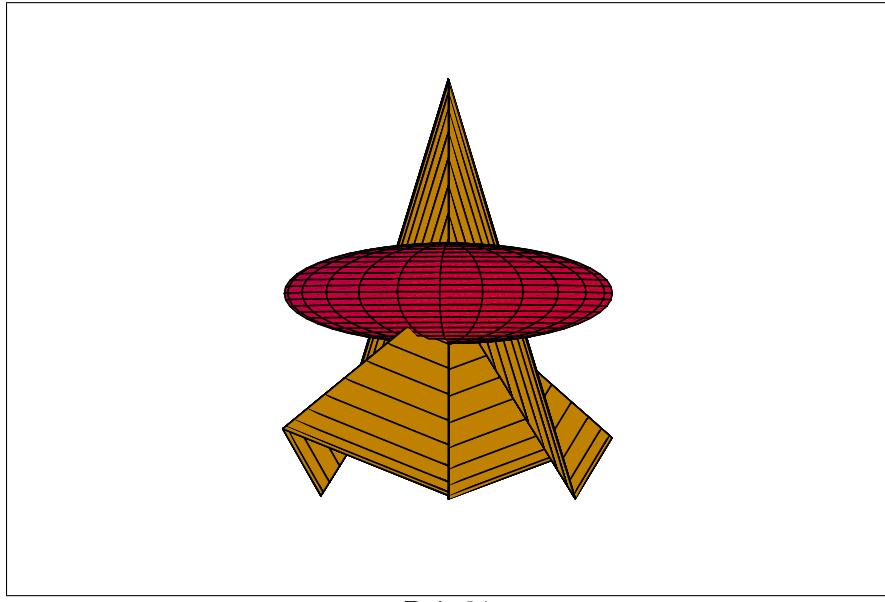
Dej. 87



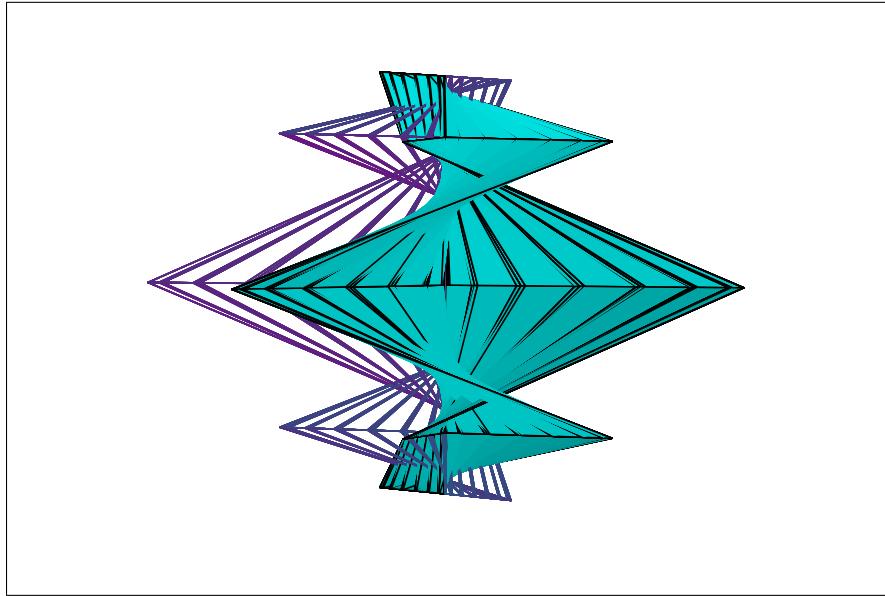
Dej. 86



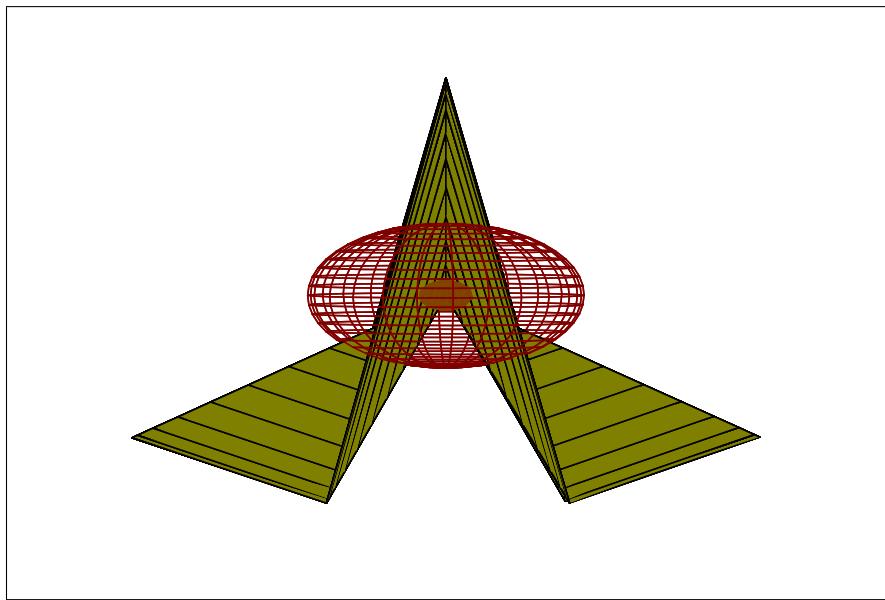
Dej. 85



Dej. 84



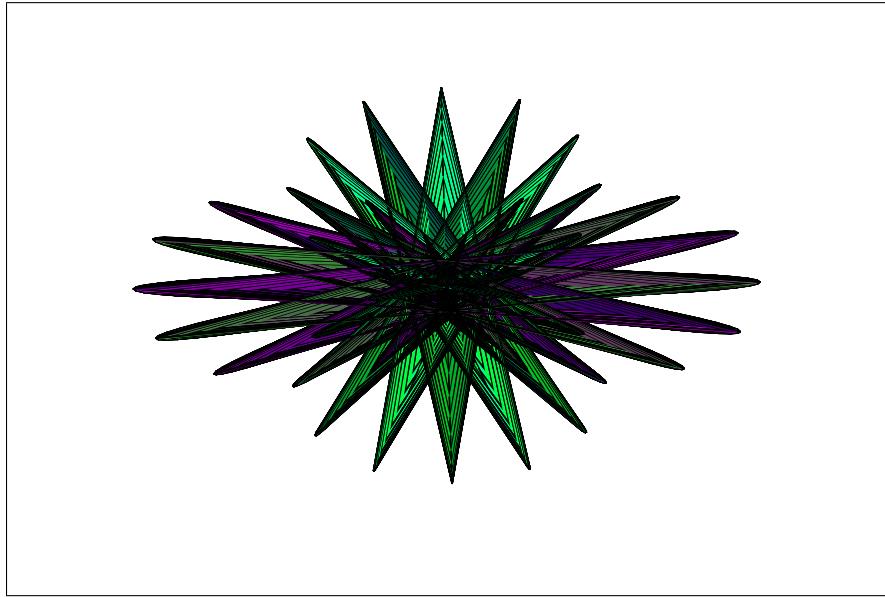
Dej. 83



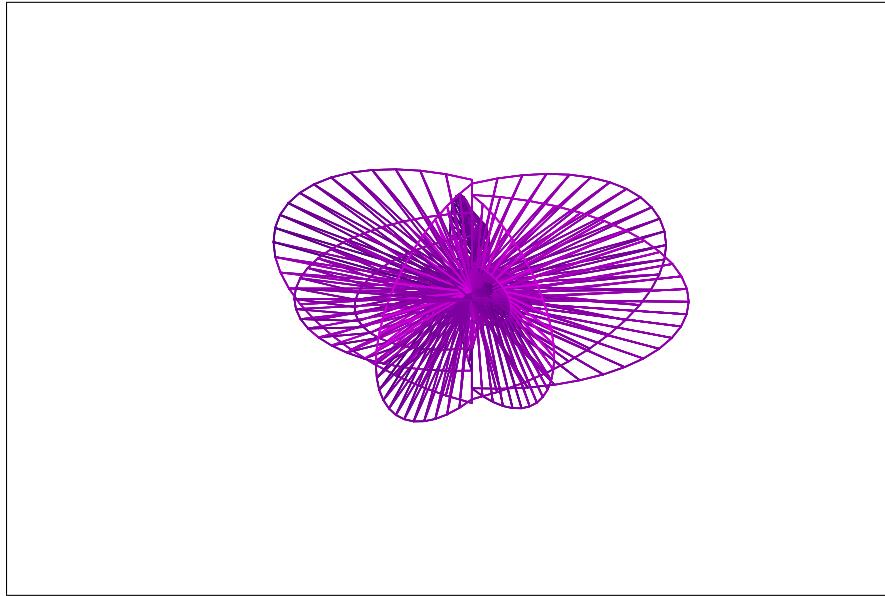
Dej. 82



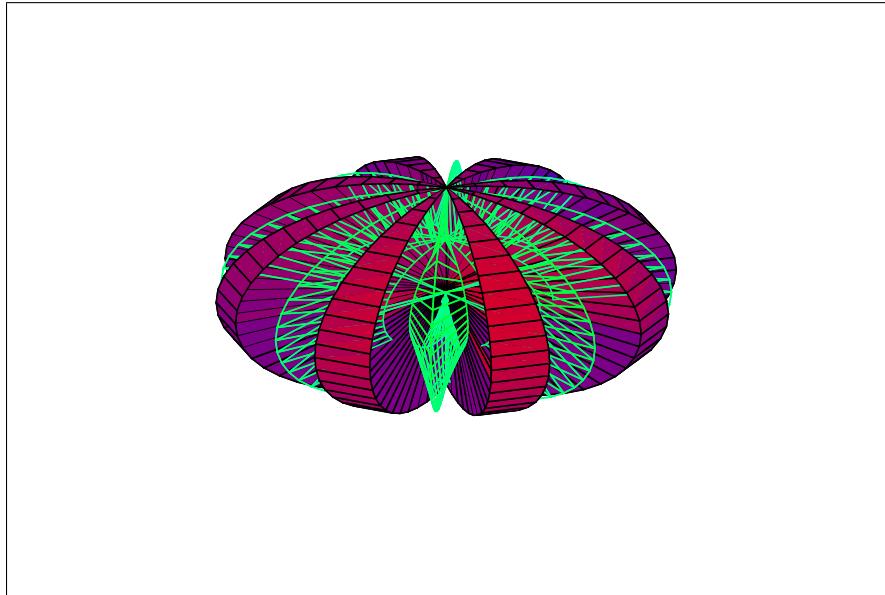
Dej. 81



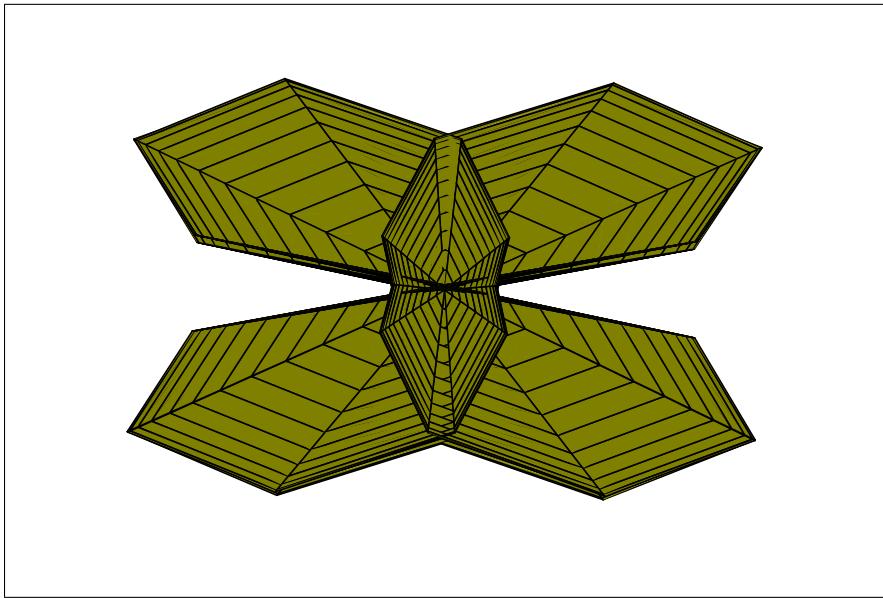
Dej. 80



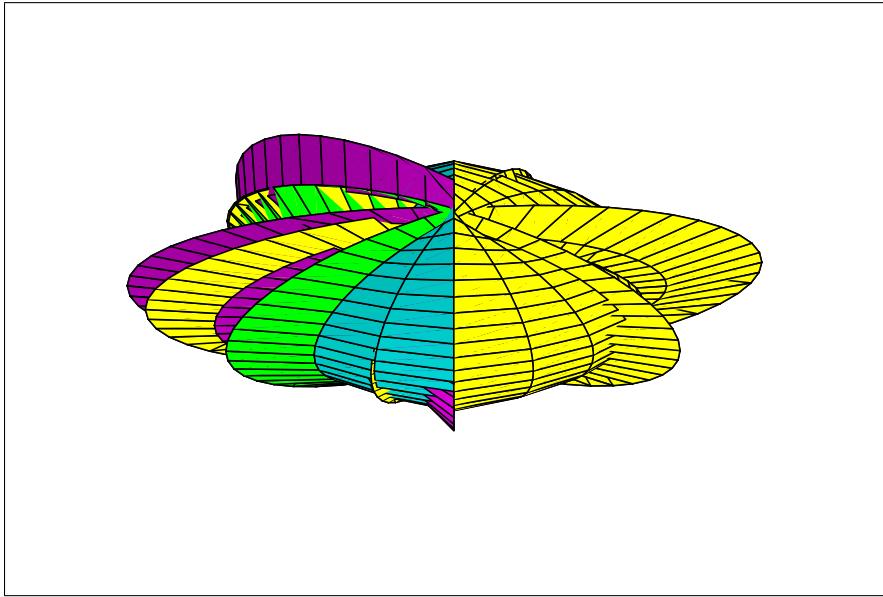
Dej. 79



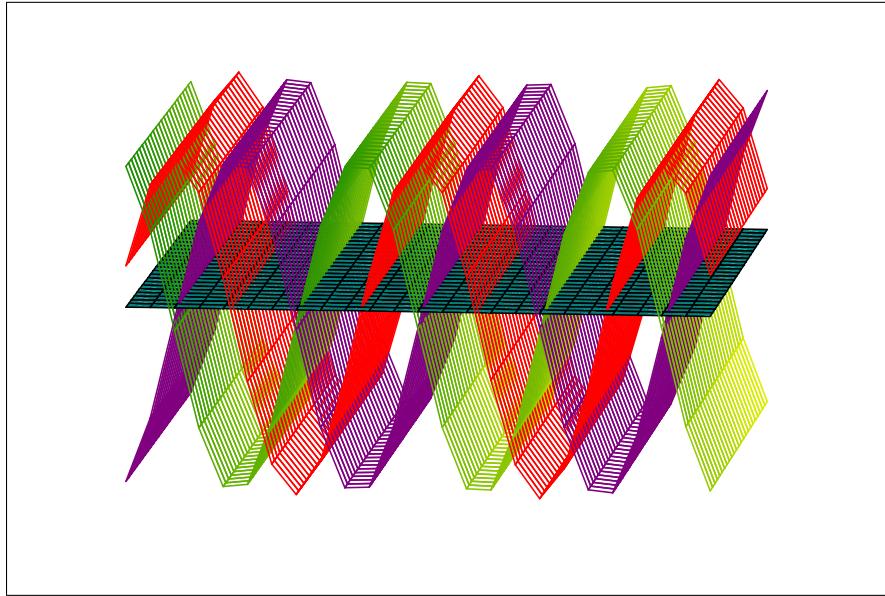
Dej. 78



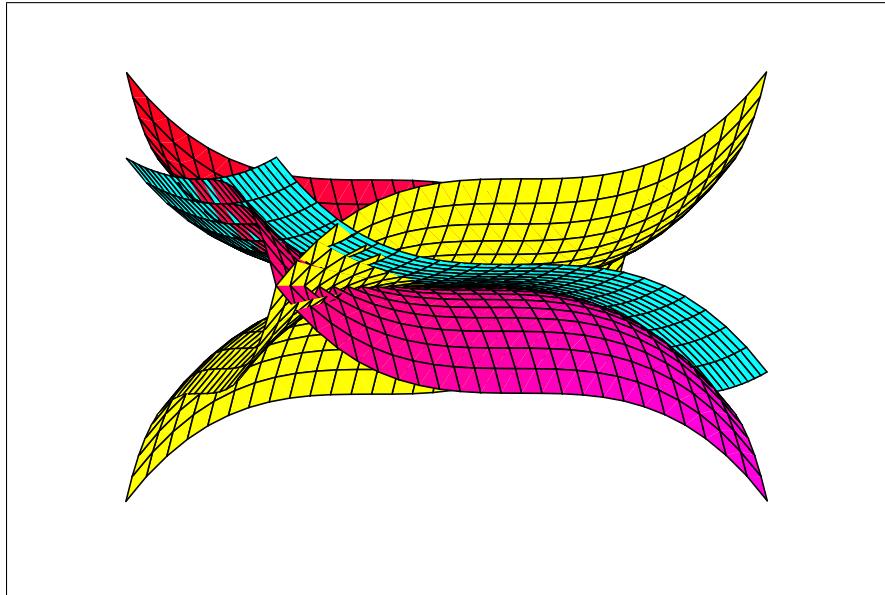
Dej. 77



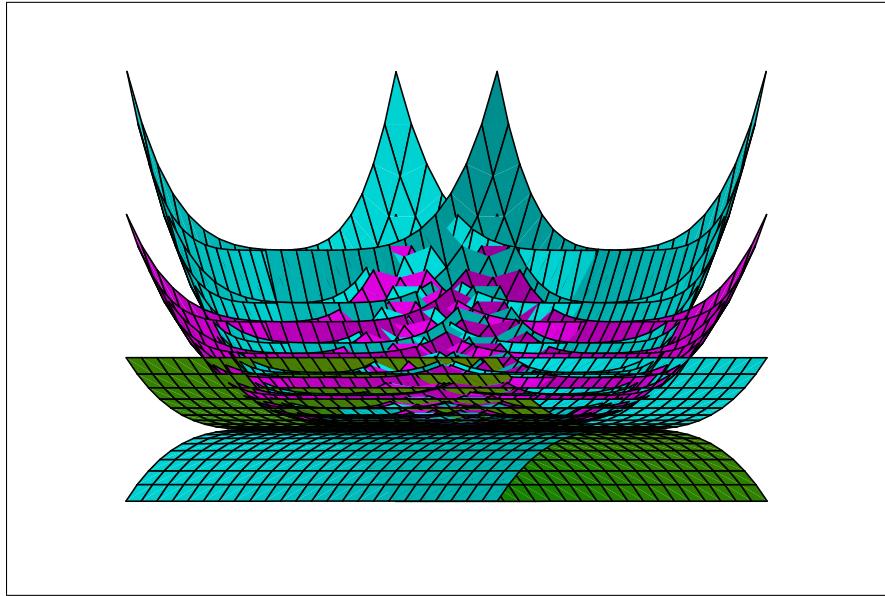
Dej. 76



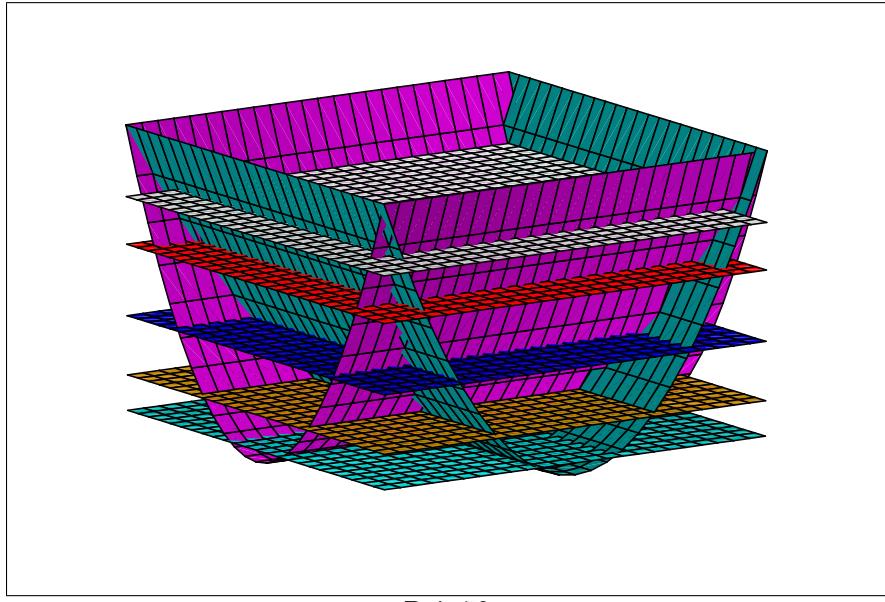
Dej. 75



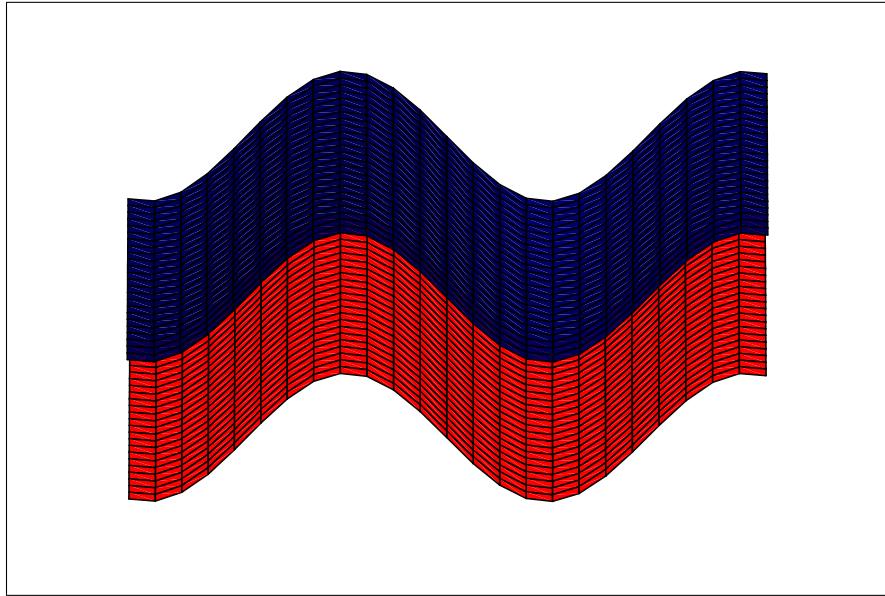
Dej. 74



Dej. 73



Dej. 72



Dej. 71 : VSU Colors

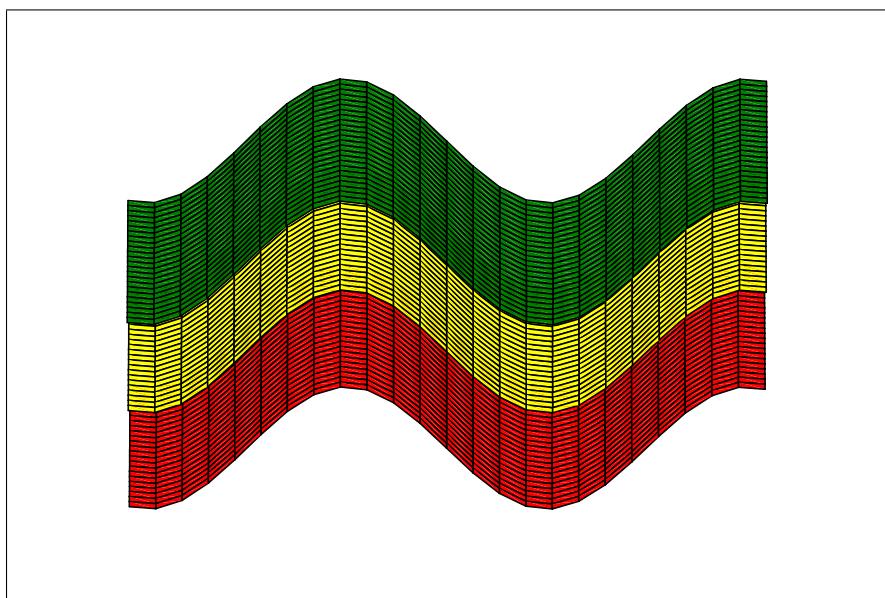
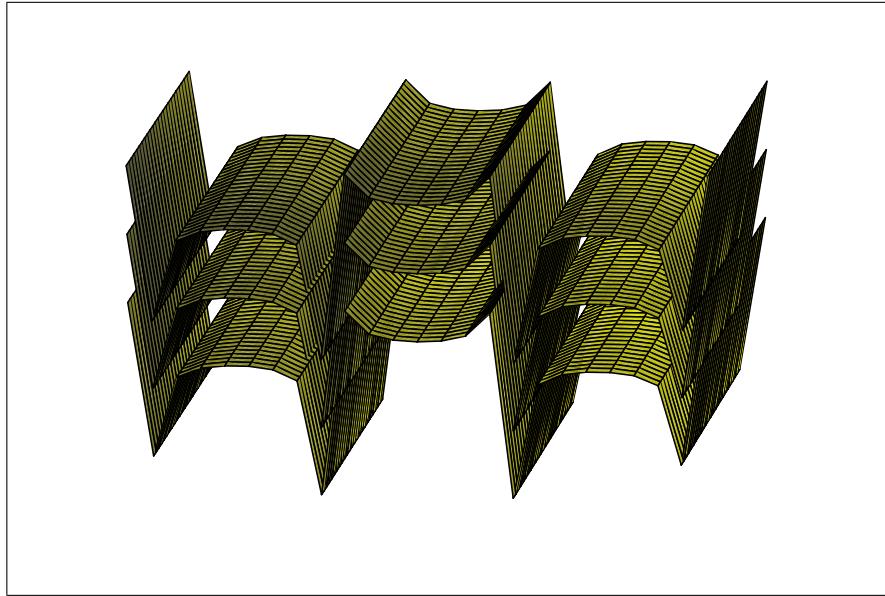
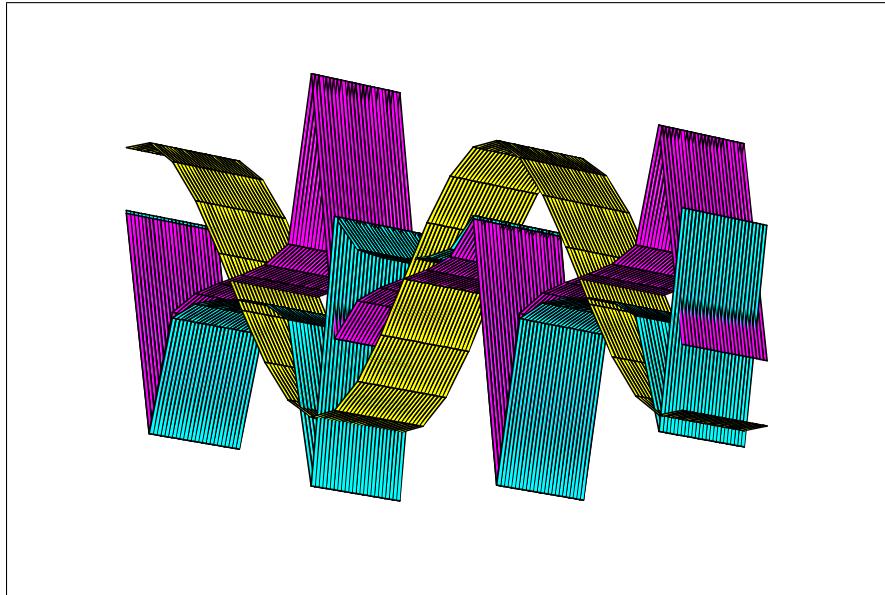


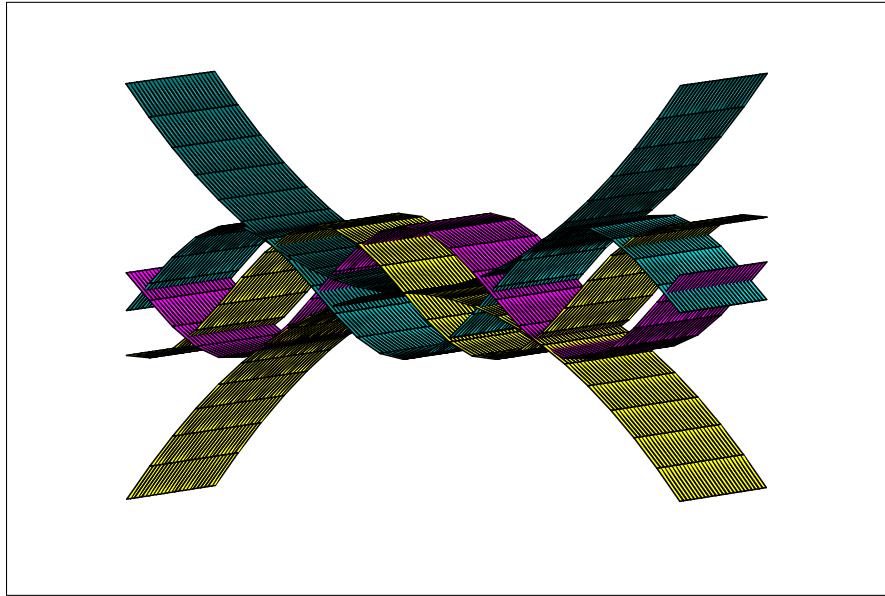
Fig. 70: Ethiopian Flag



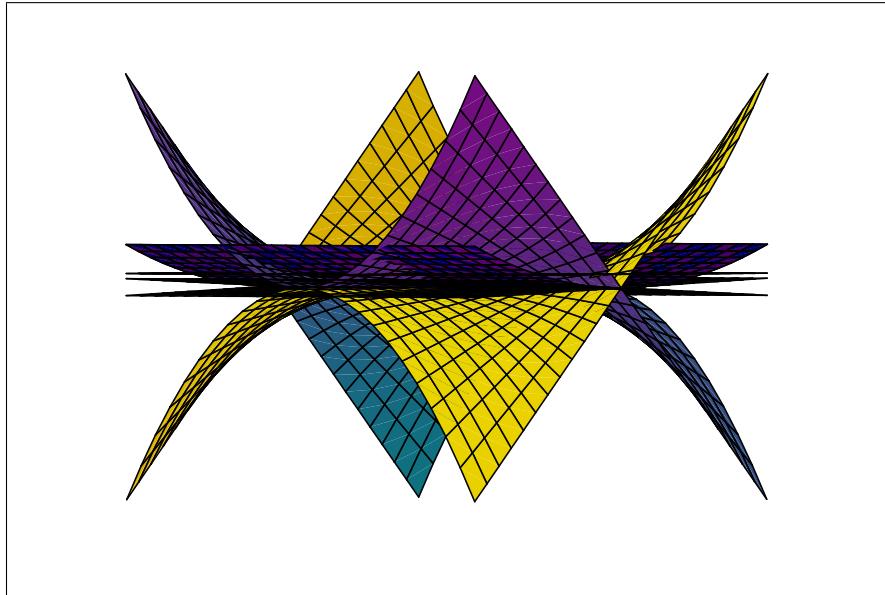
Dej. 69: Stack of secant surfaces



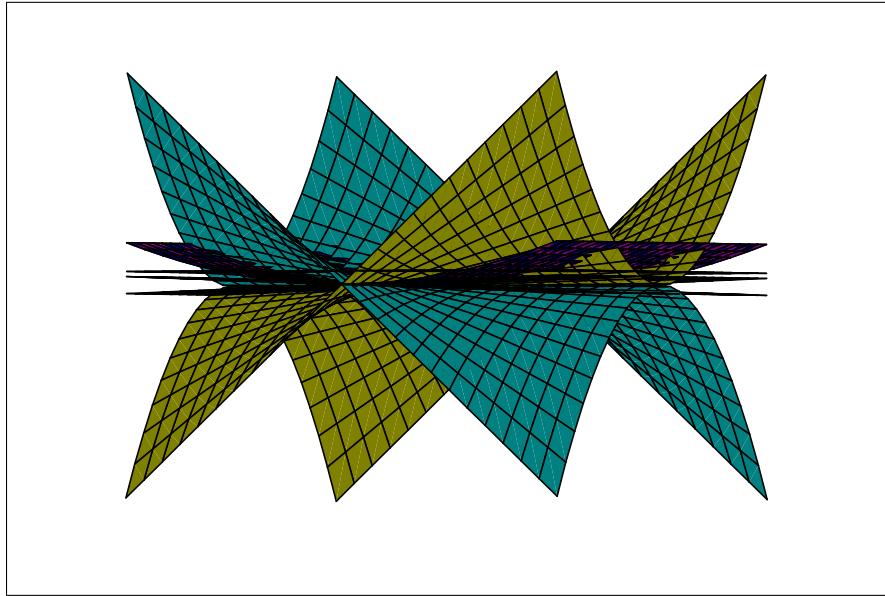
Dej. 68



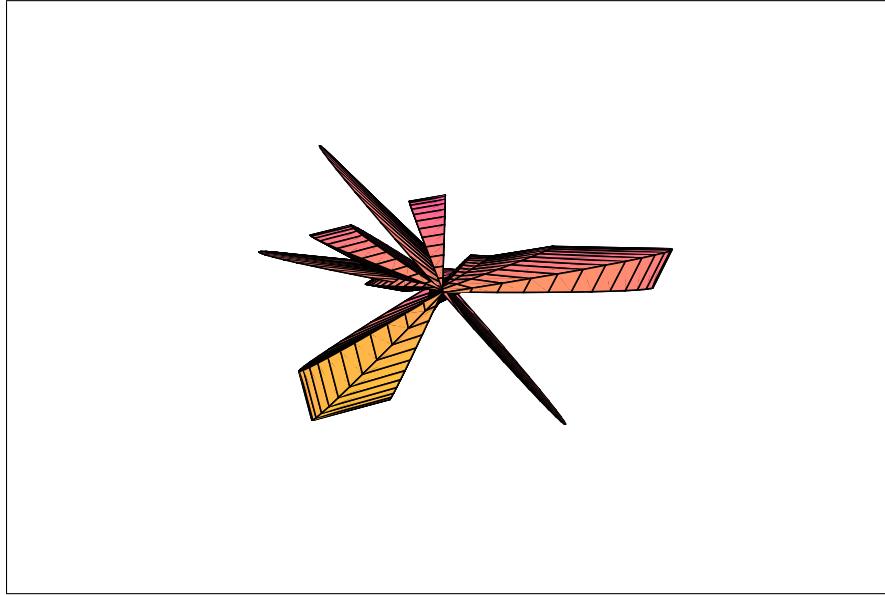
Dej. 67



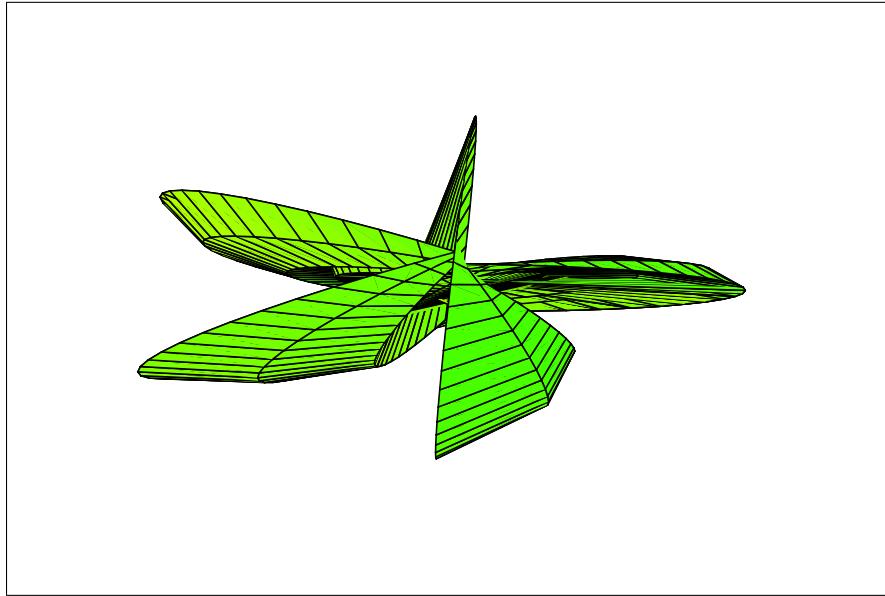
Dej. 66



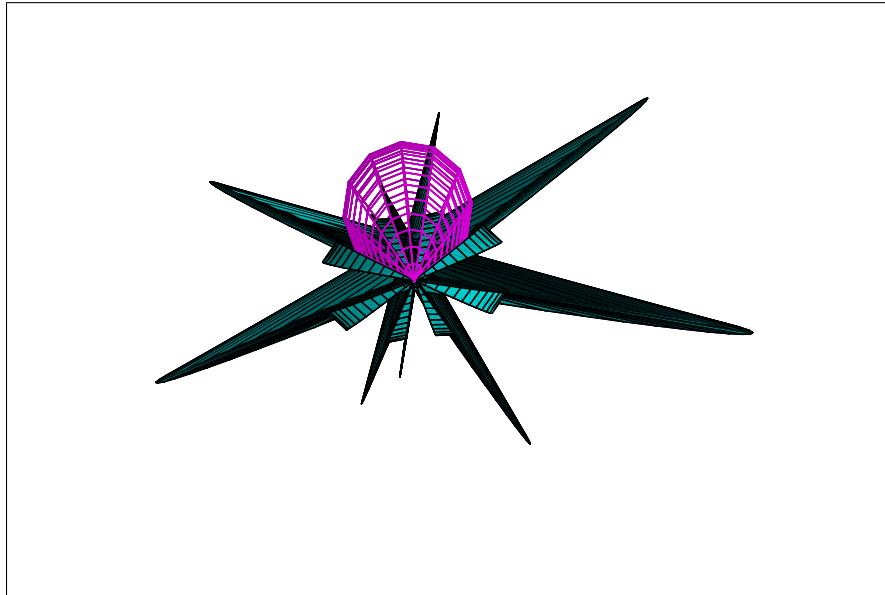
Dej. 65



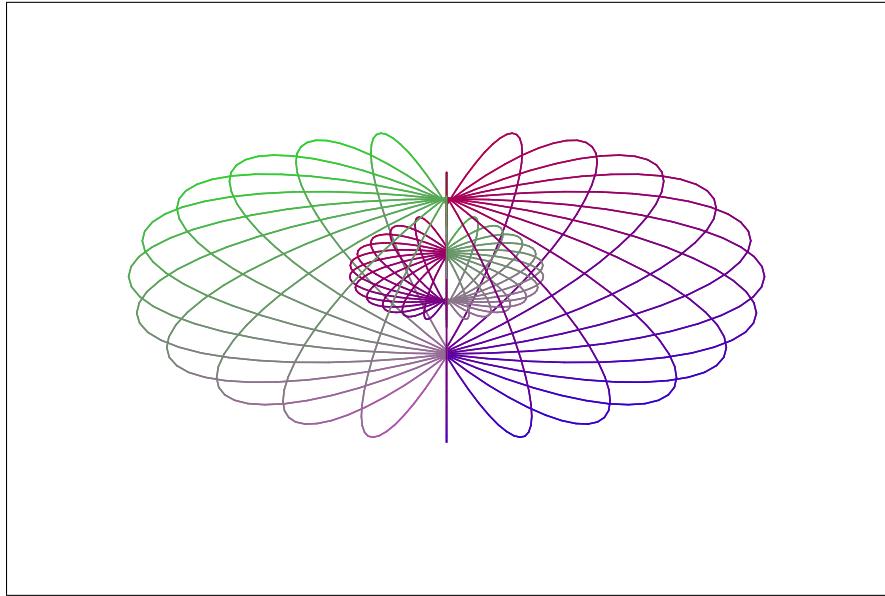
Dej. 64



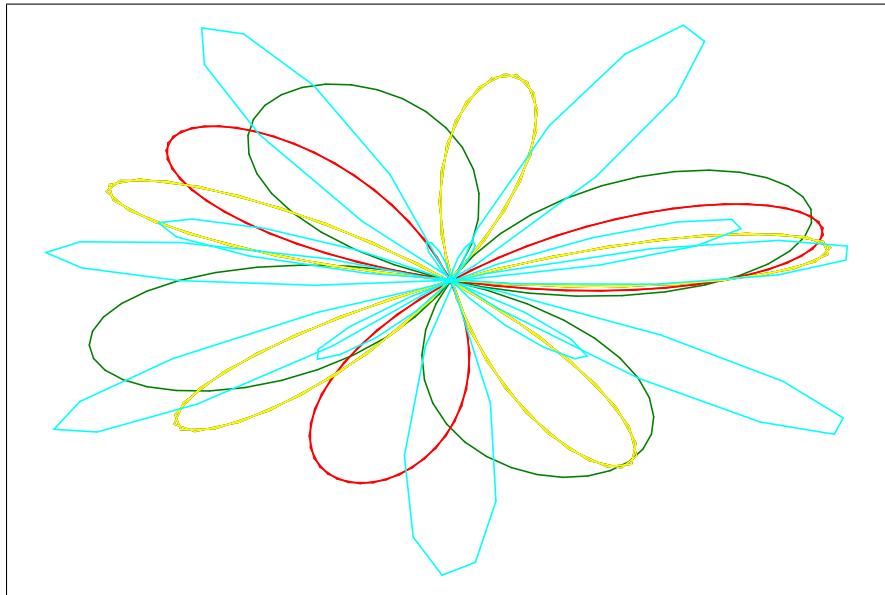
Dej. 63

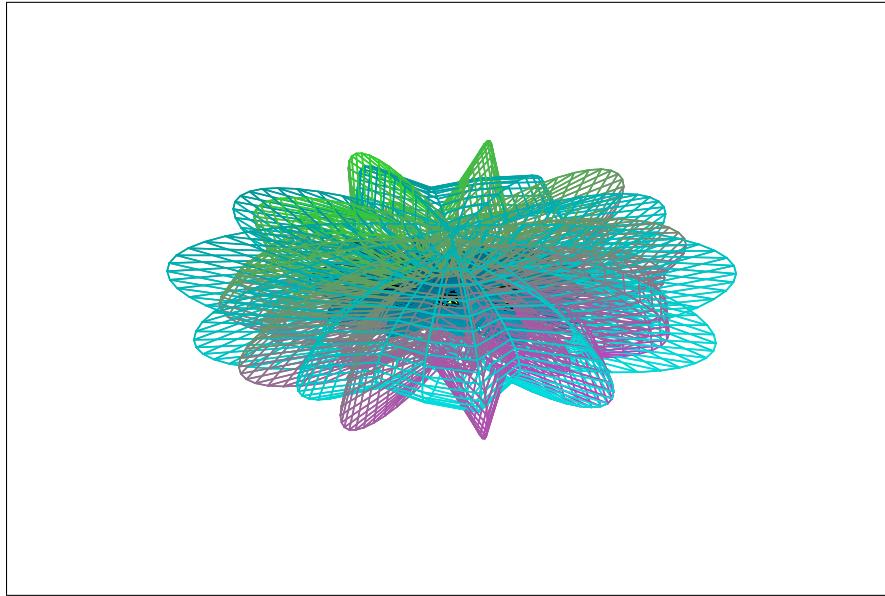


Dej. 62

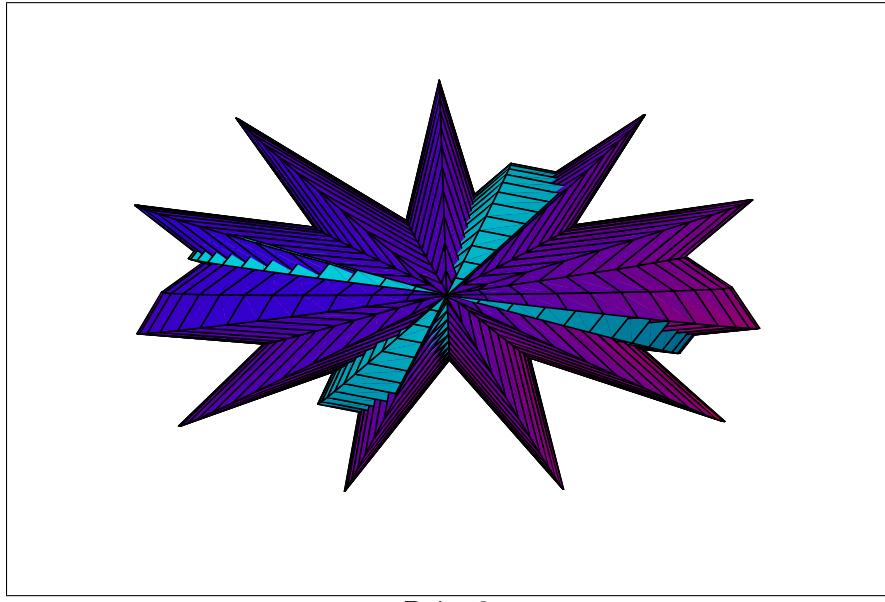


Dej. 61

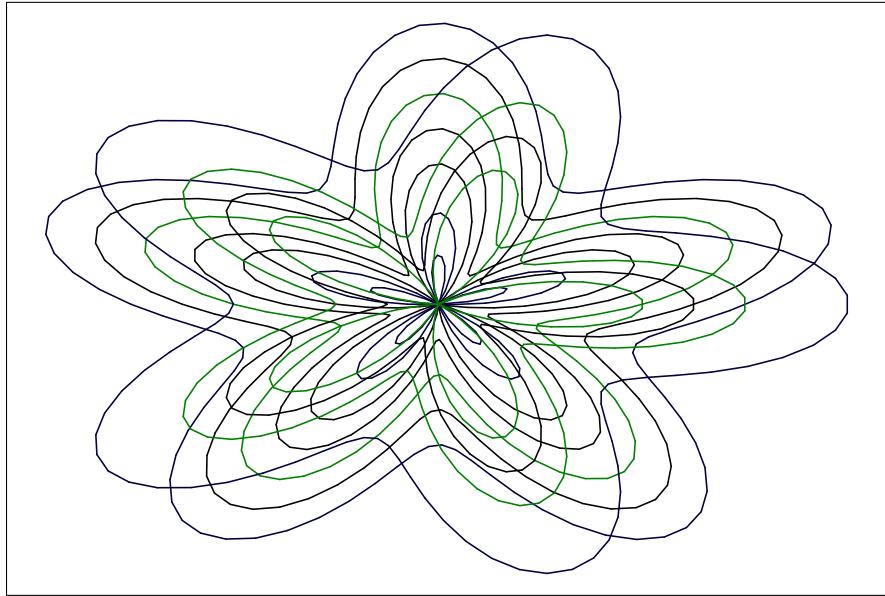




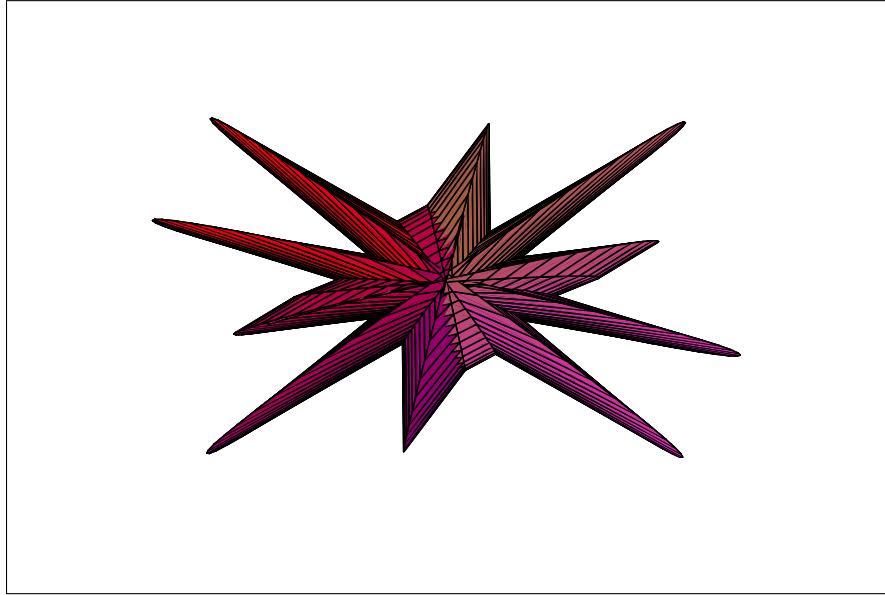
Dej. 60



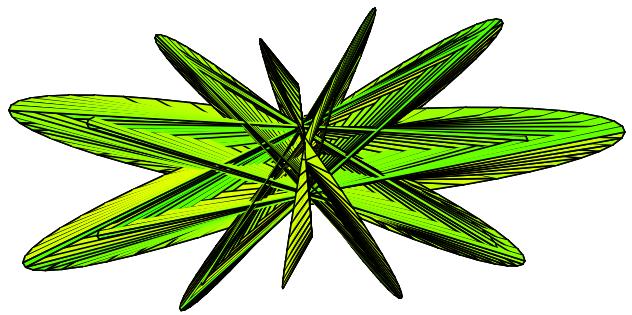
Dej. 59



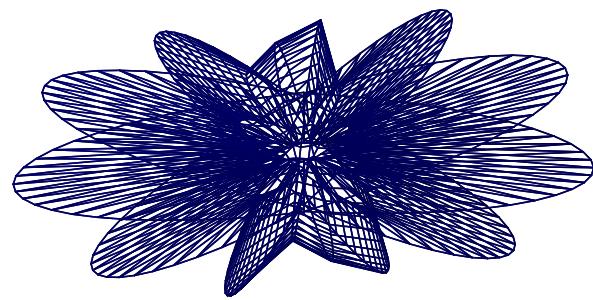
Dej. 58



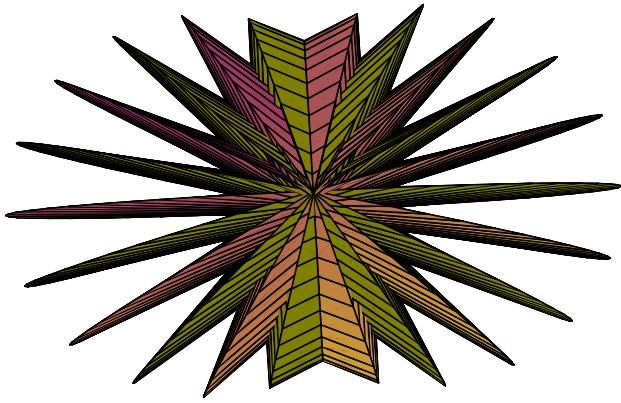
Dej. 57



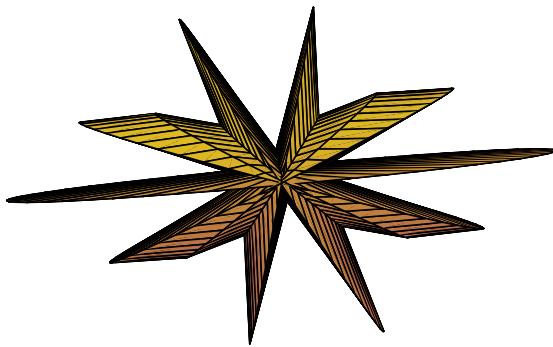
Dej. 56



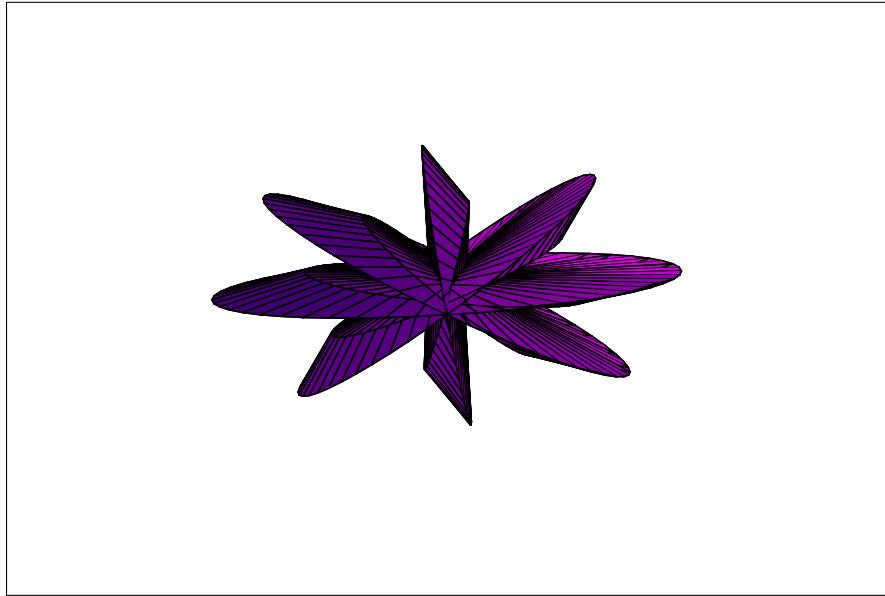
Dej. 55



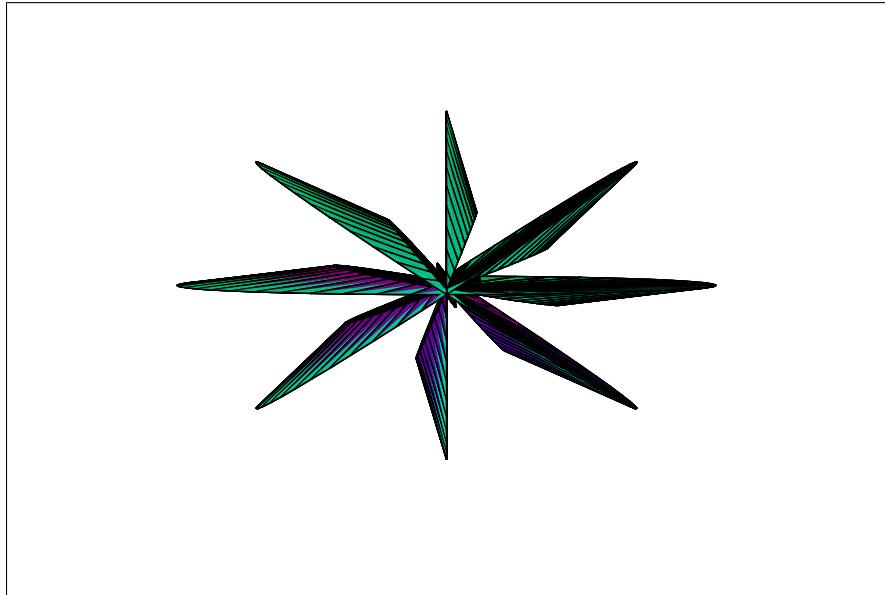
Dej. 54



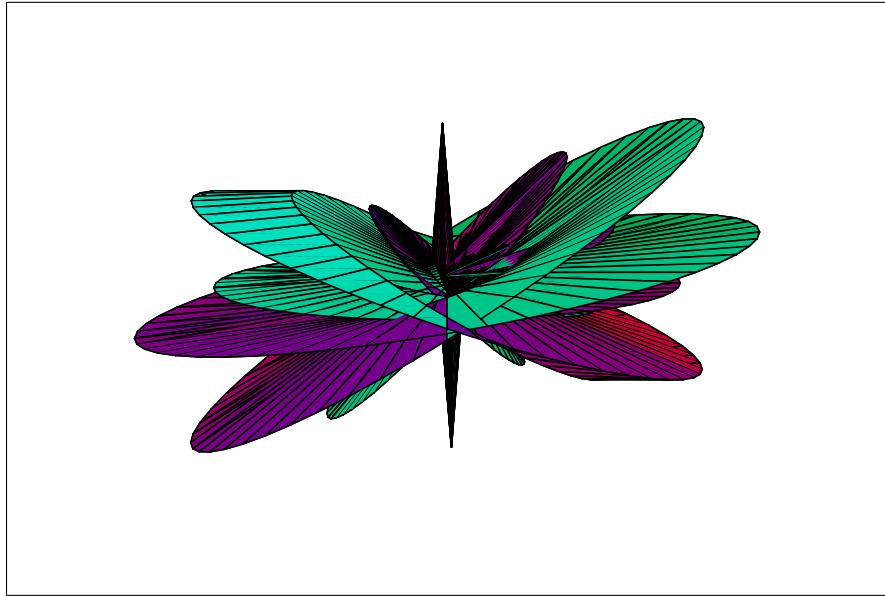
Dej. 53



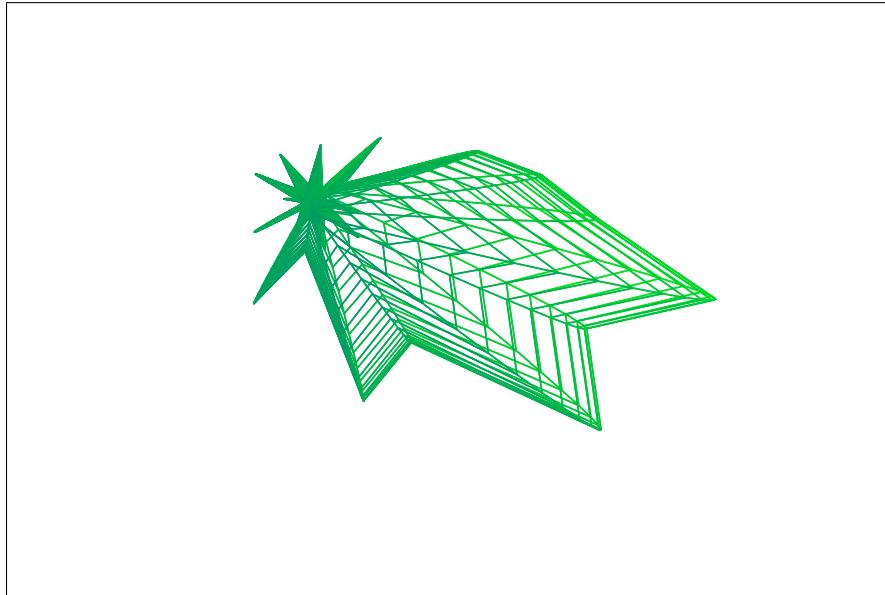
Dej. 52



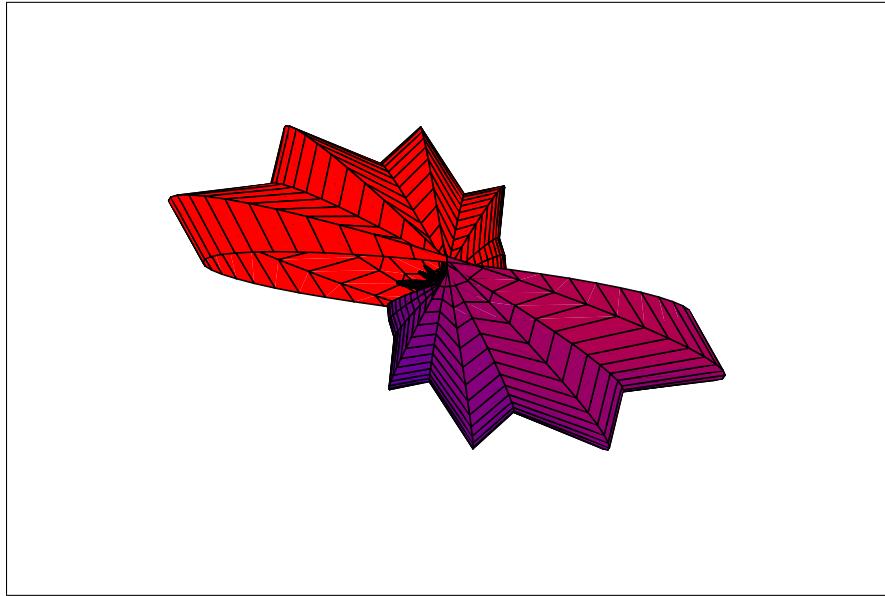
Dej. 51



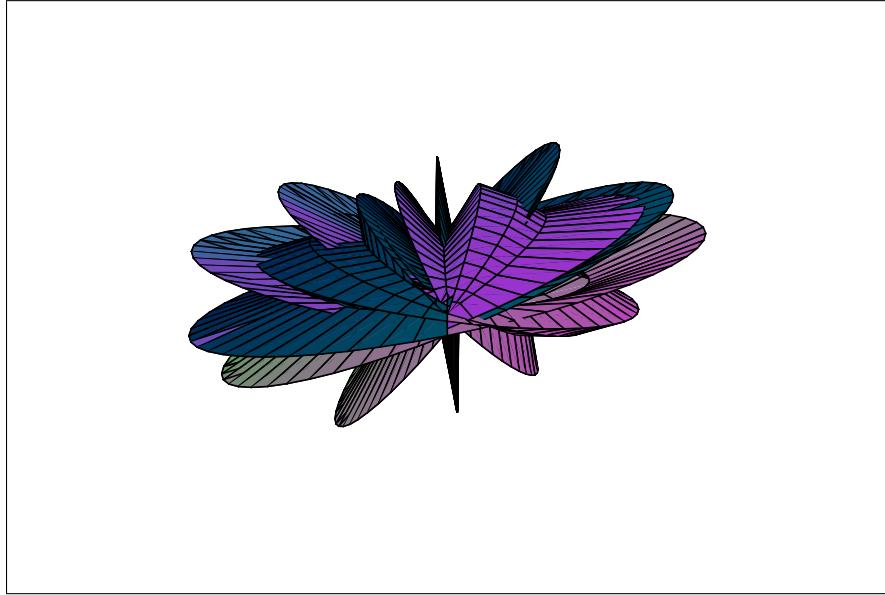
Dej. 50



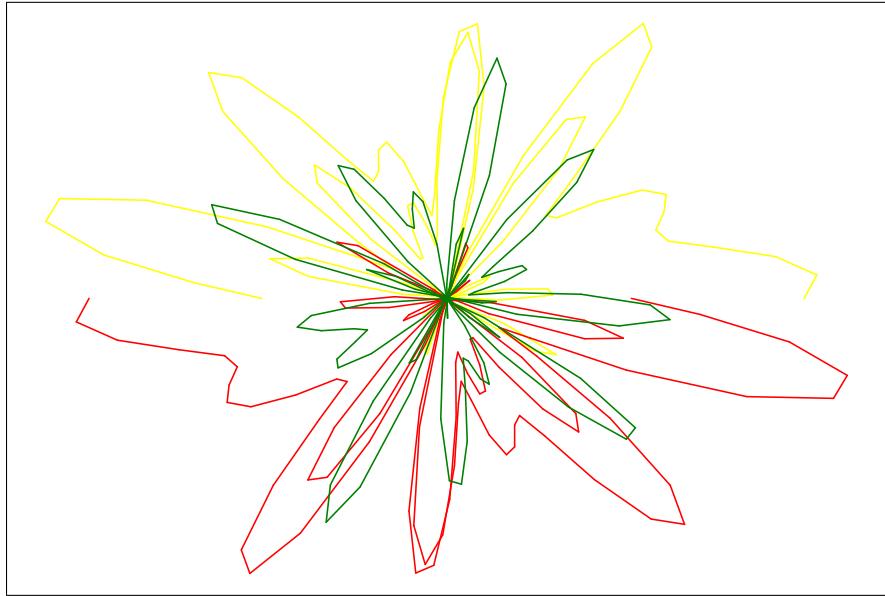
Dej. 49



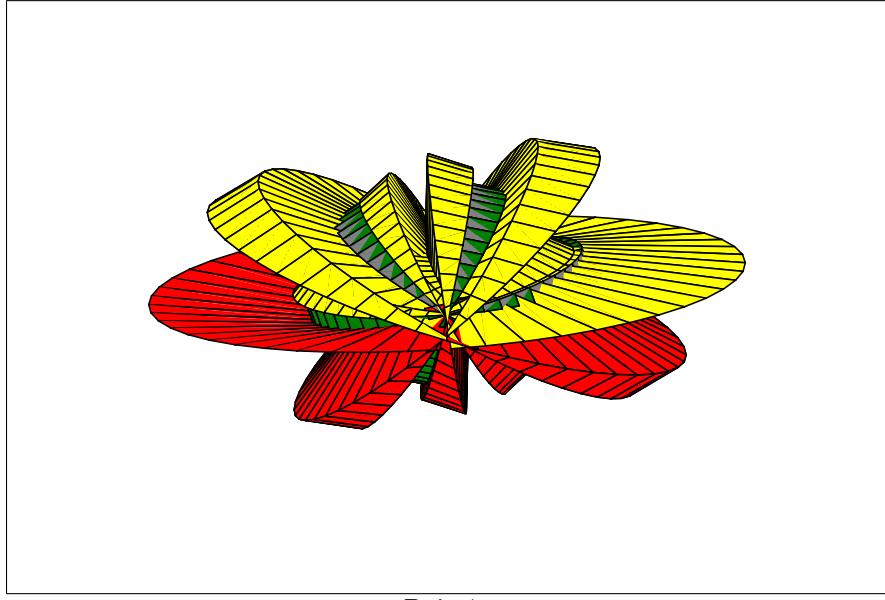
Dej. 48



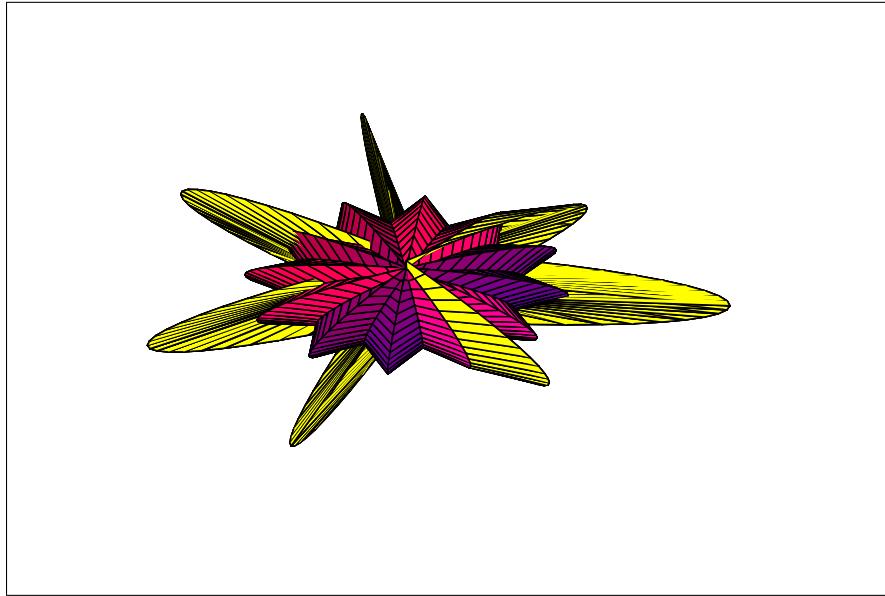
Dej. 47



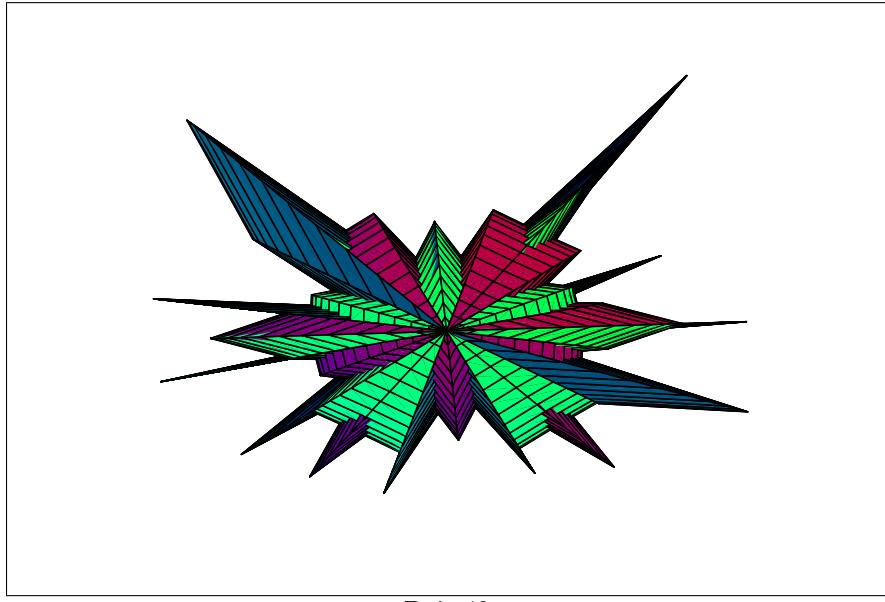
Dej. 46



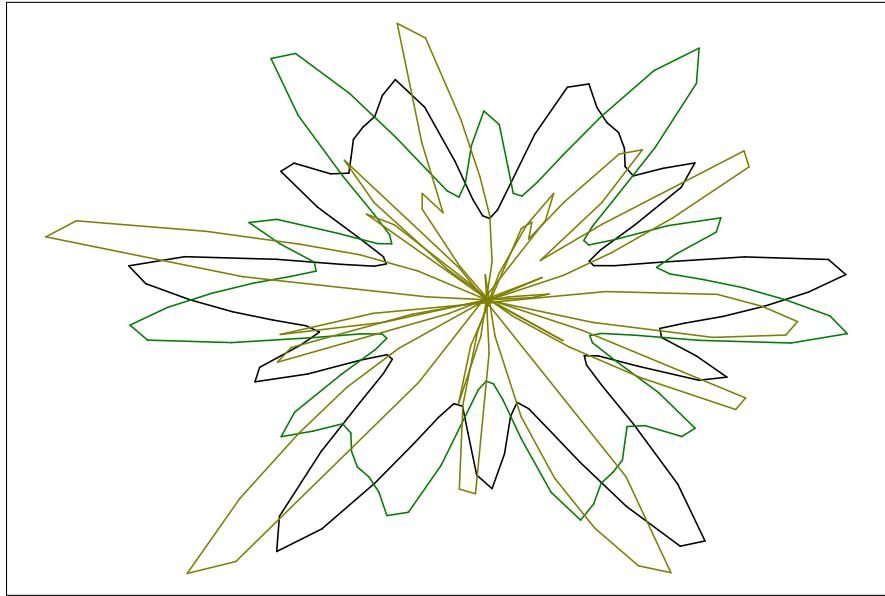
Dej. 45



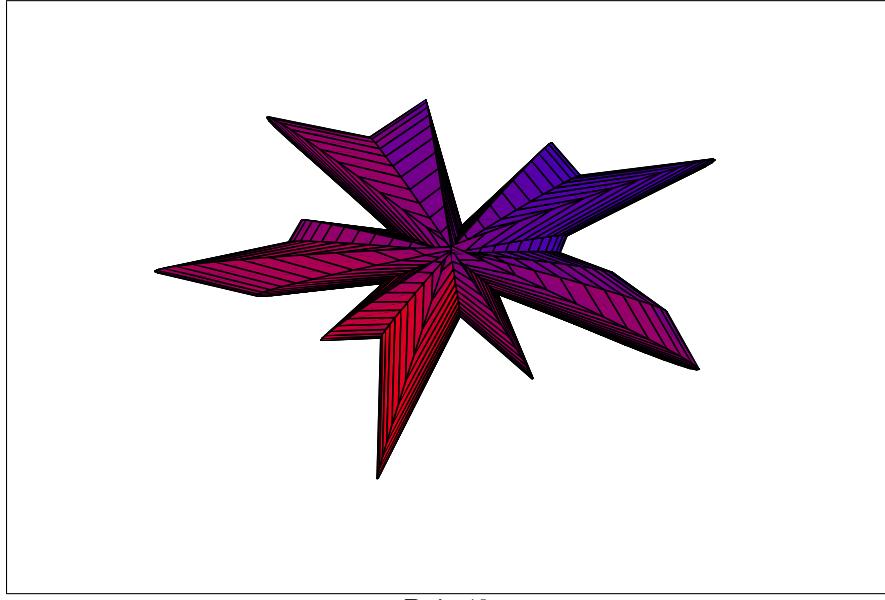
Dej. 43



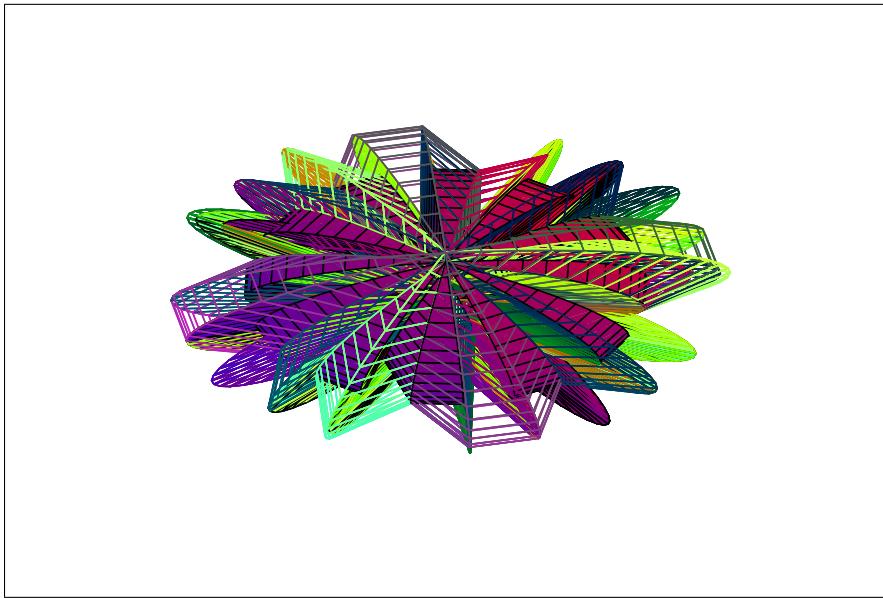
Dej. 42



Dej. 41



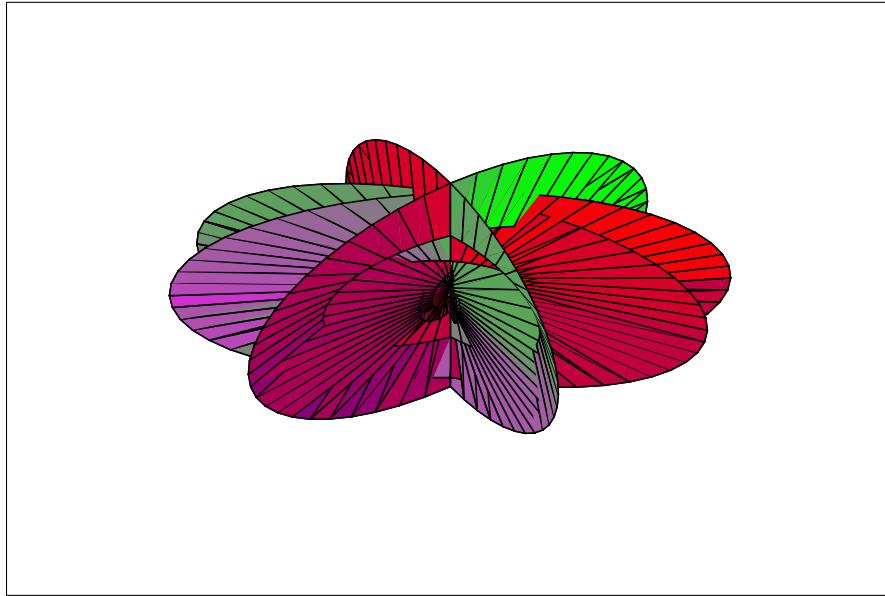
Dej. 40



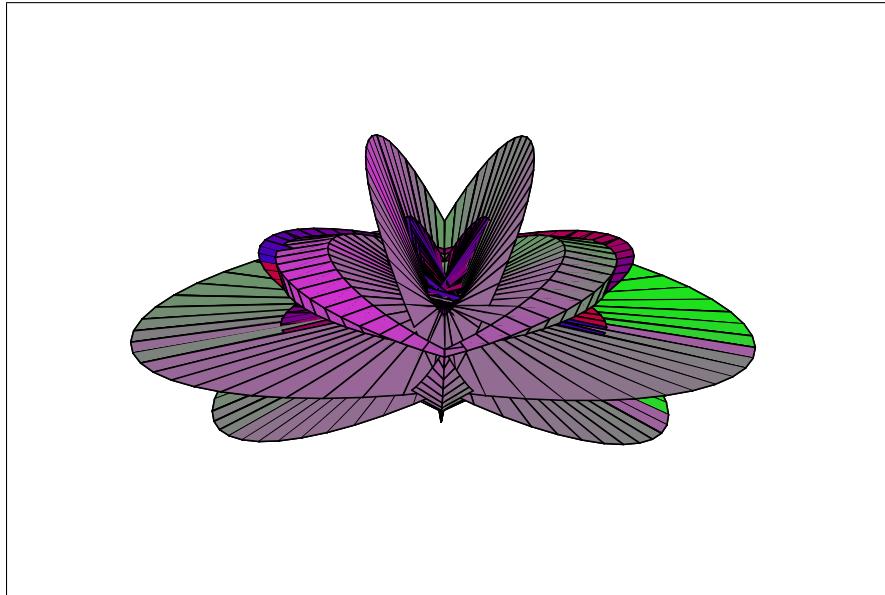
Dej. 39



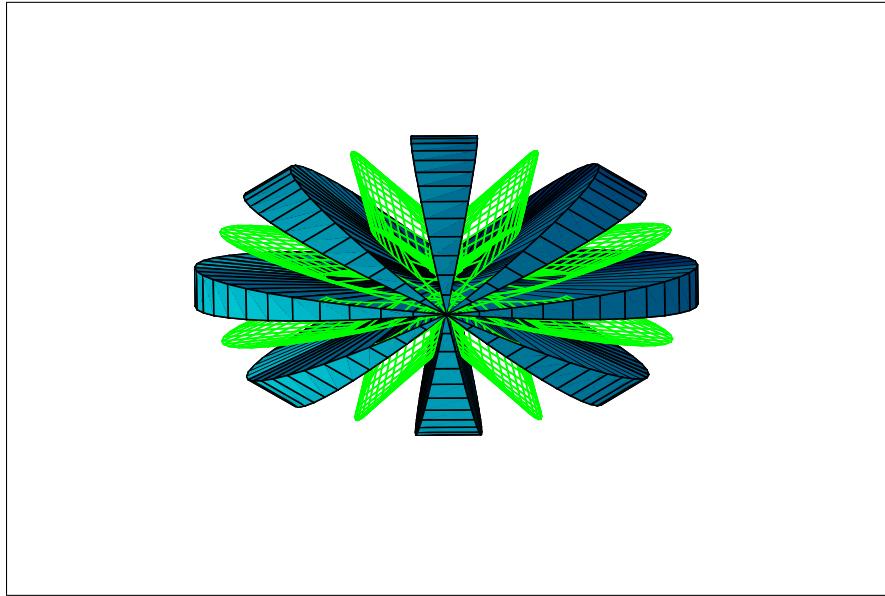
Dej. 38



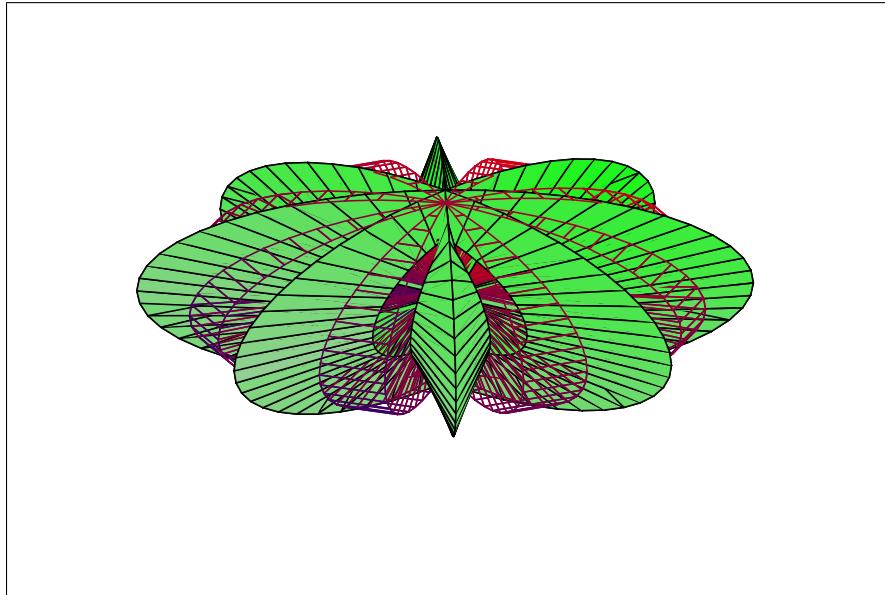
Dej. 37



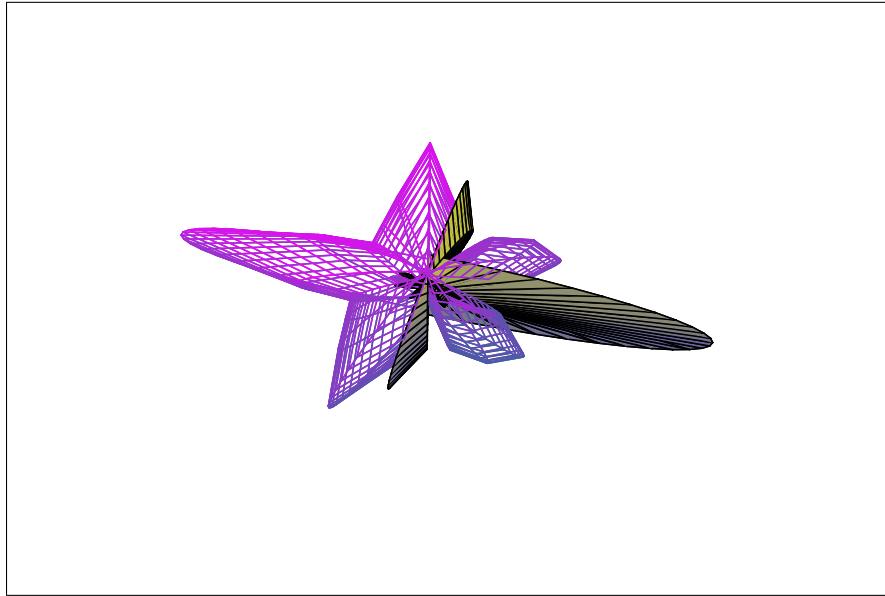
Dej. 36



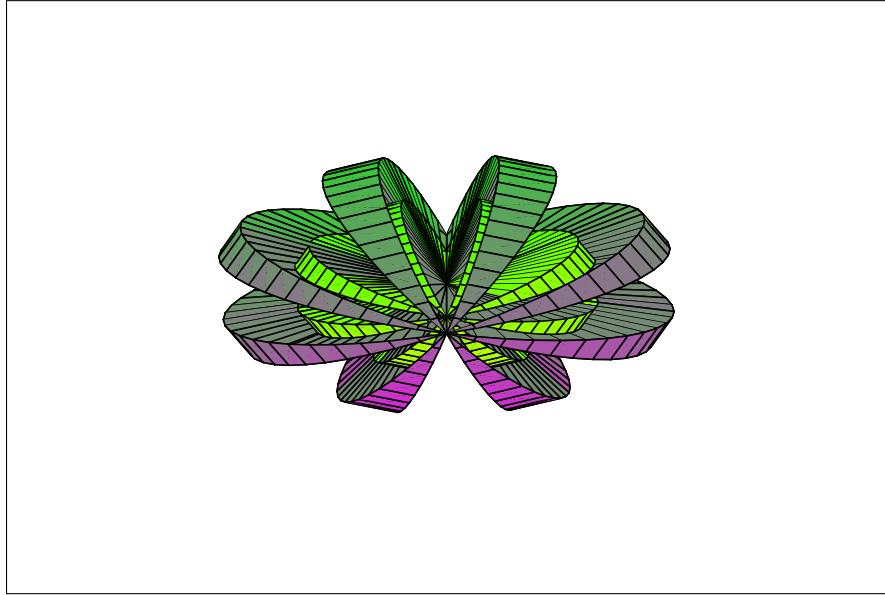
Dej. 35



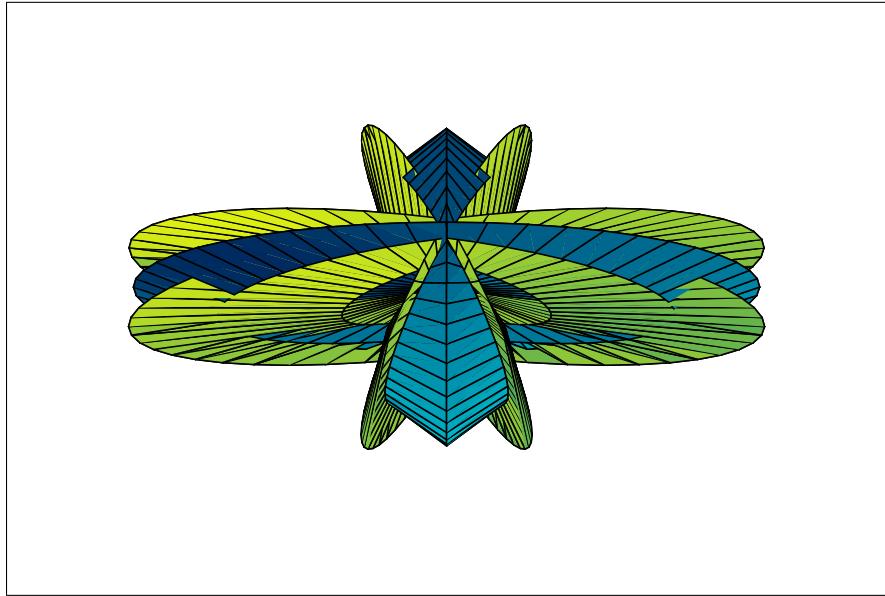
Dej. 34



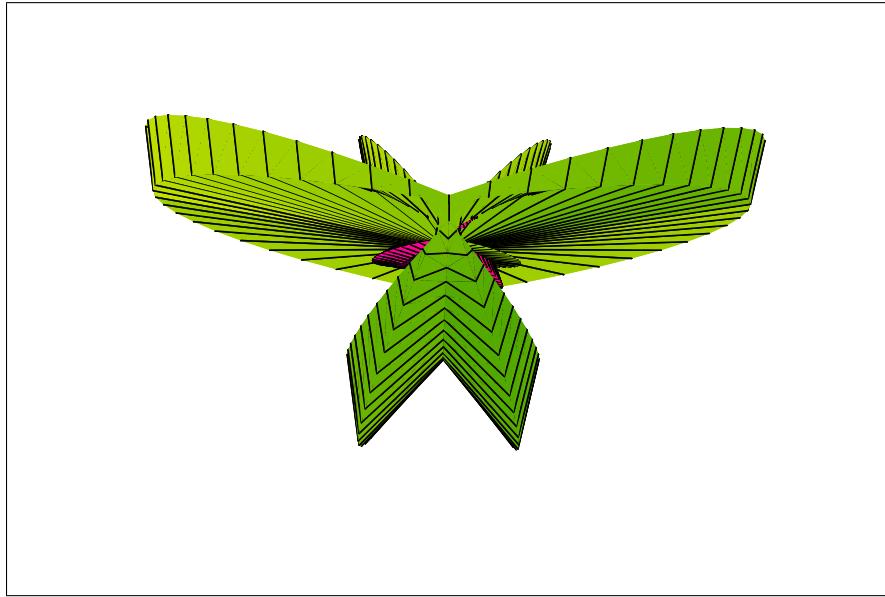
Dej. 33



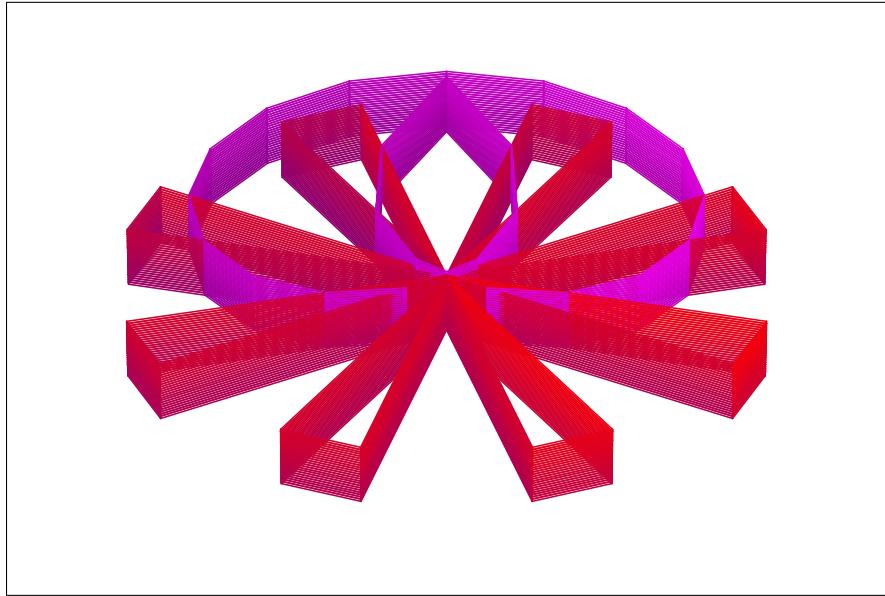
Dej. 32



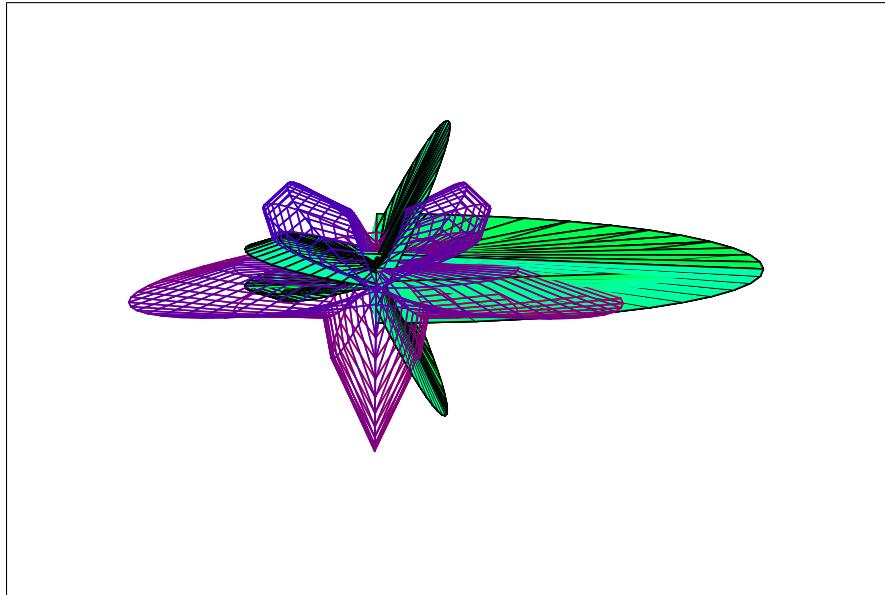
Dej. 31



Dej. 30



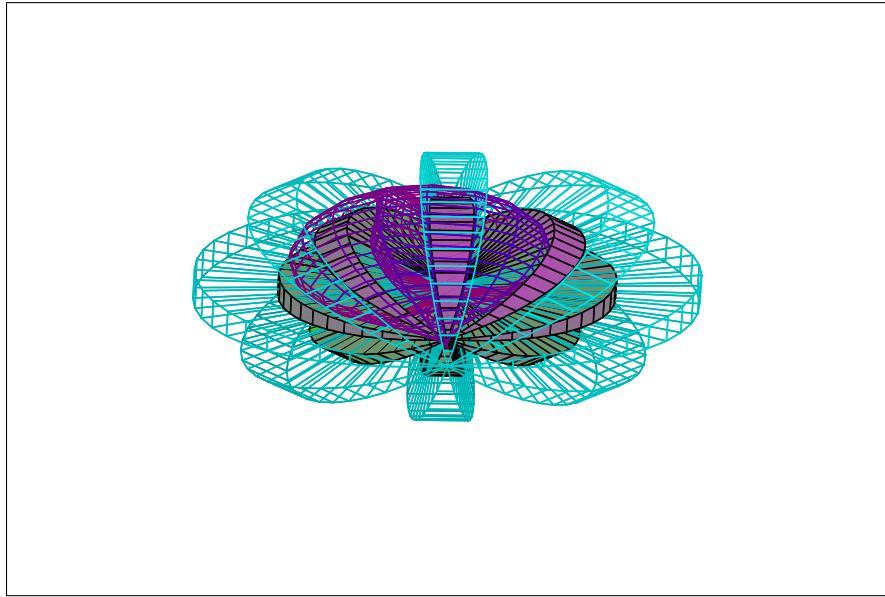
Dej.29



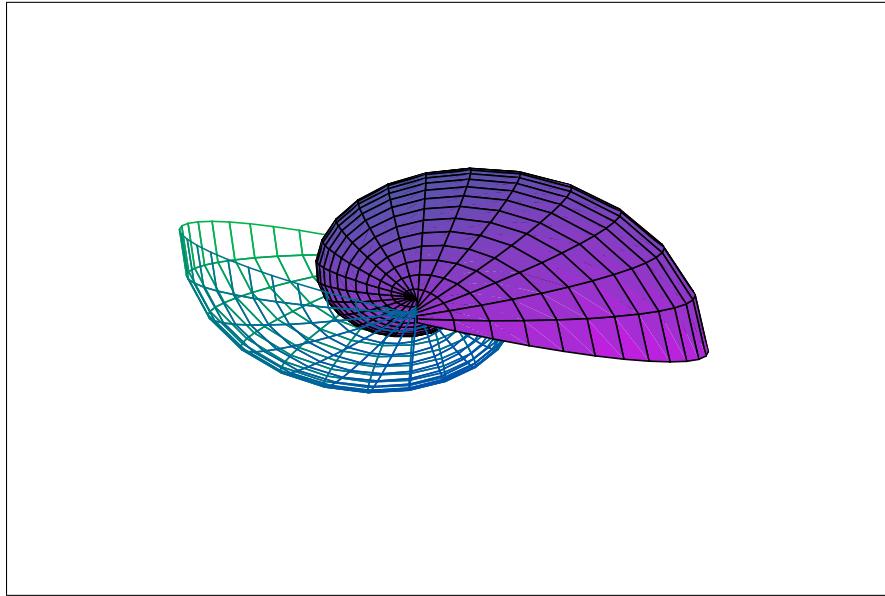
Dej. 28



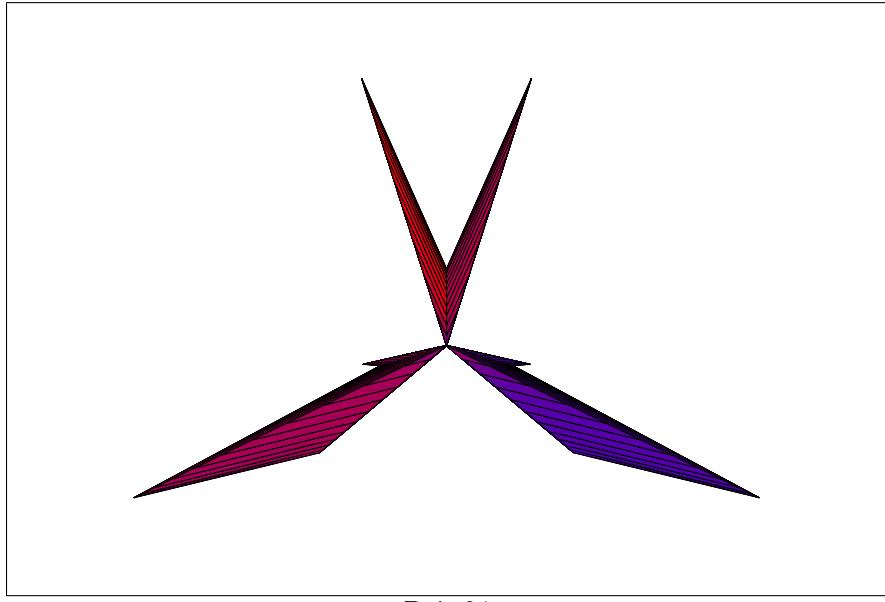
Dej. 27



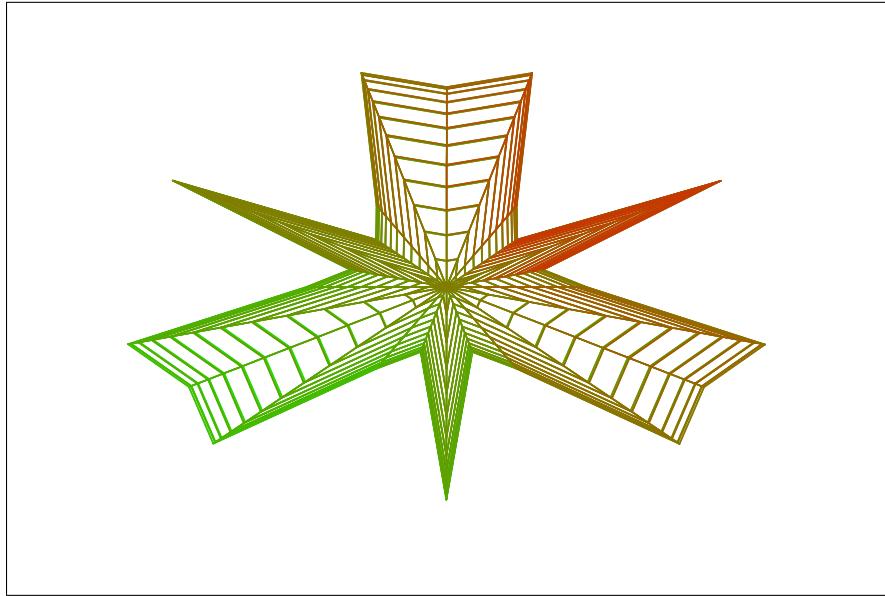
Dej. 26



Dej. 25



Dej. 24



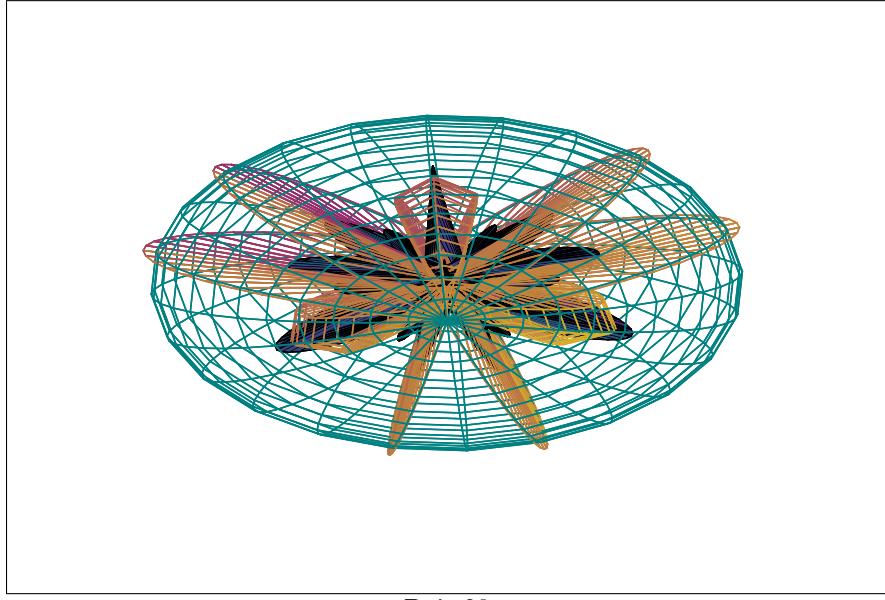
Dej. 23



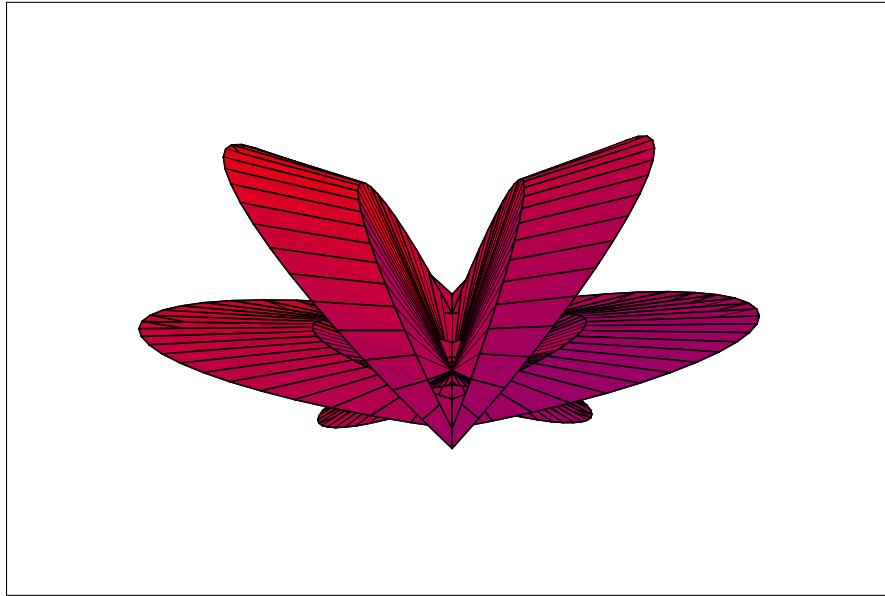
Dej. 22



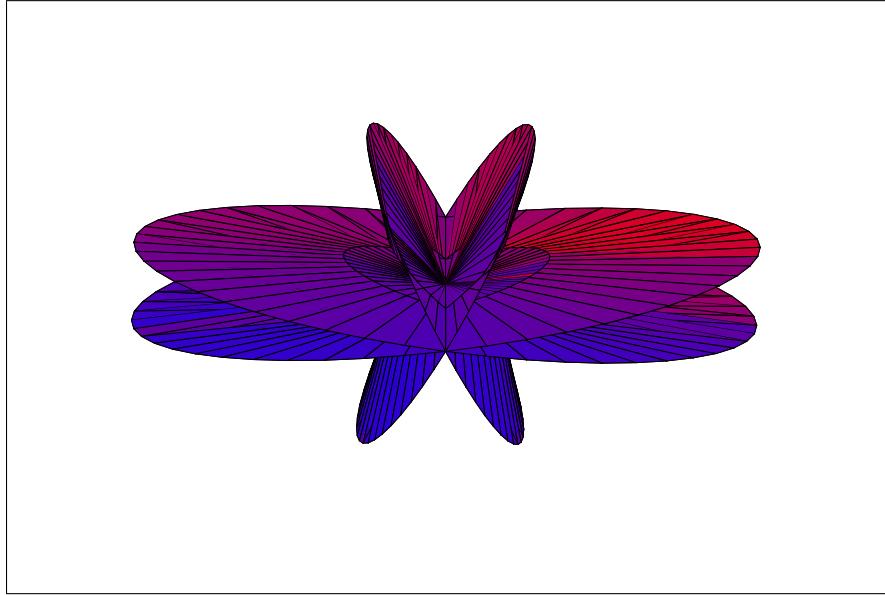
Dej. 21



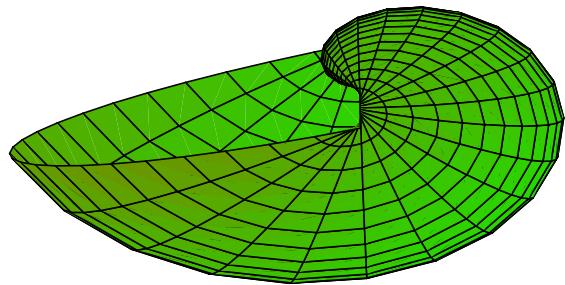
Dej. 20



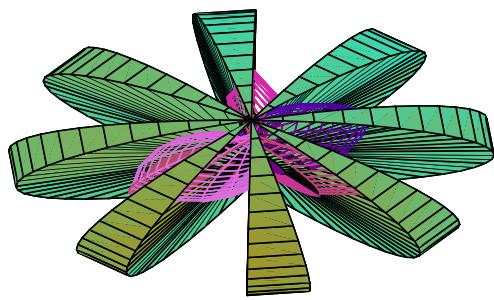
Dej. 19



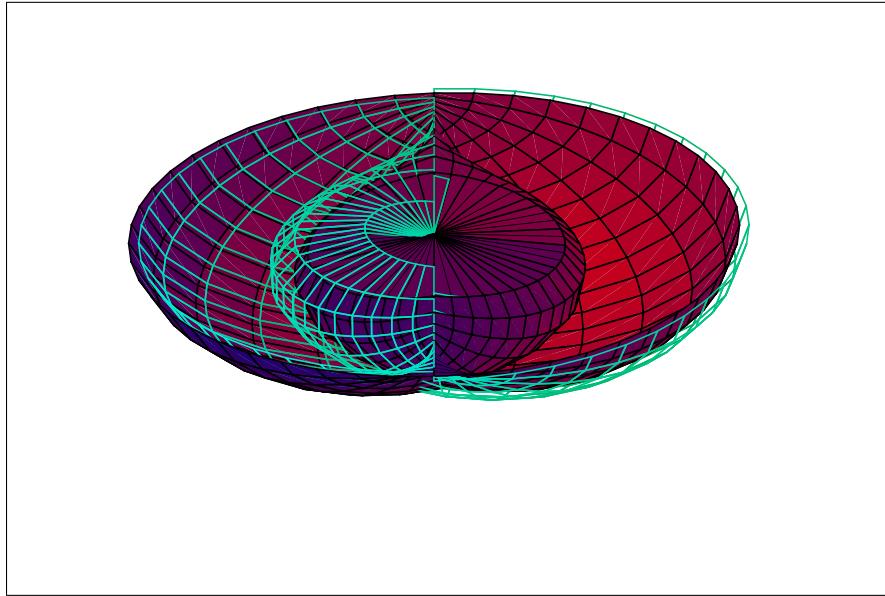
Dej. 18



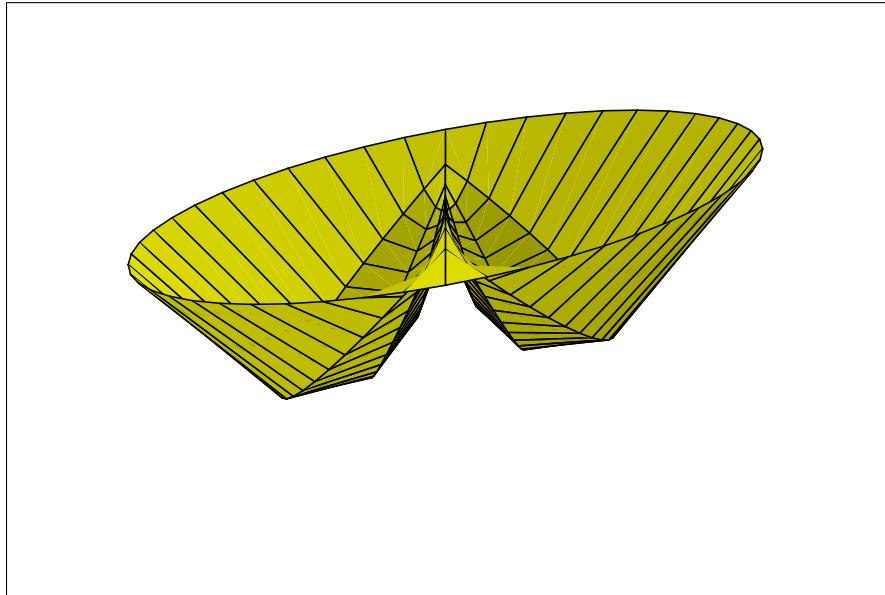
Dej. 17



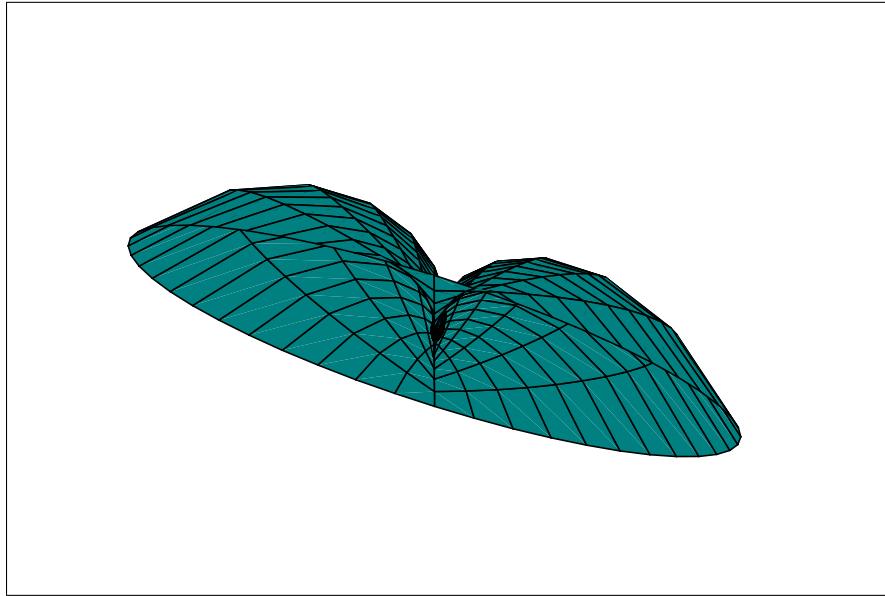
Dej. 16



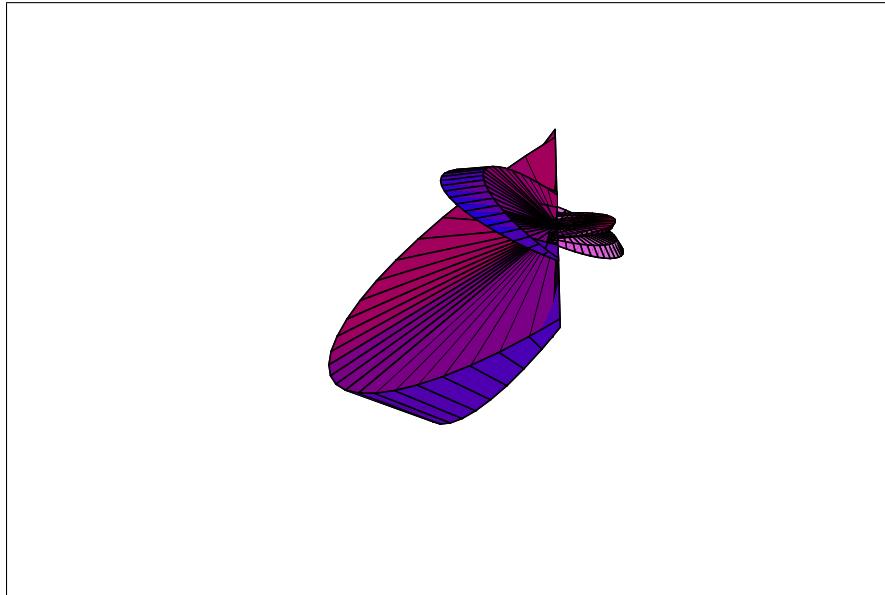
Dej. 15



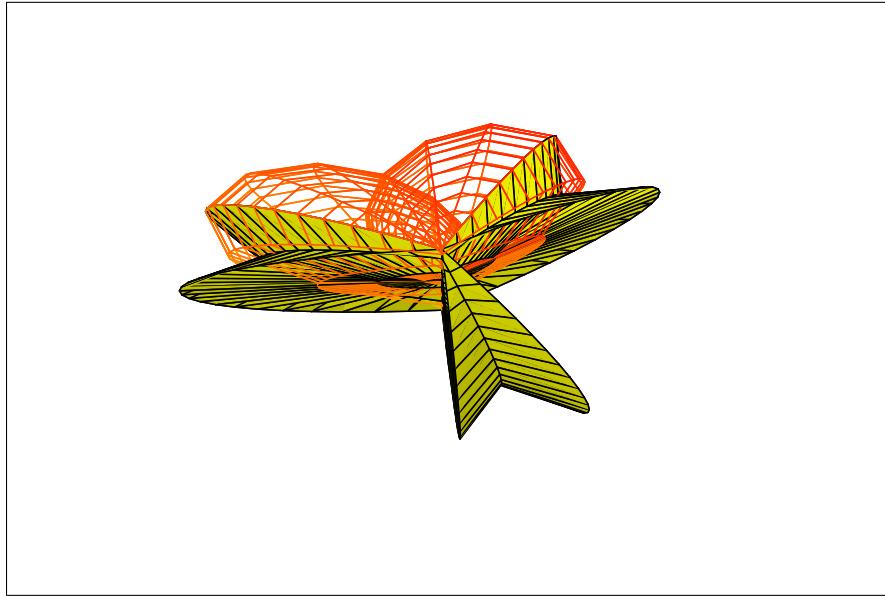
Dej. 14



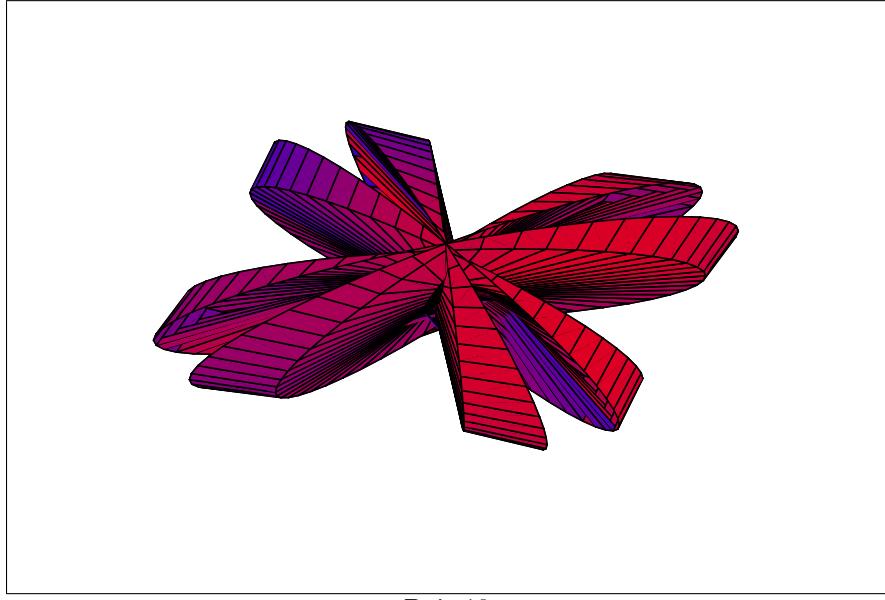
Dej. 13



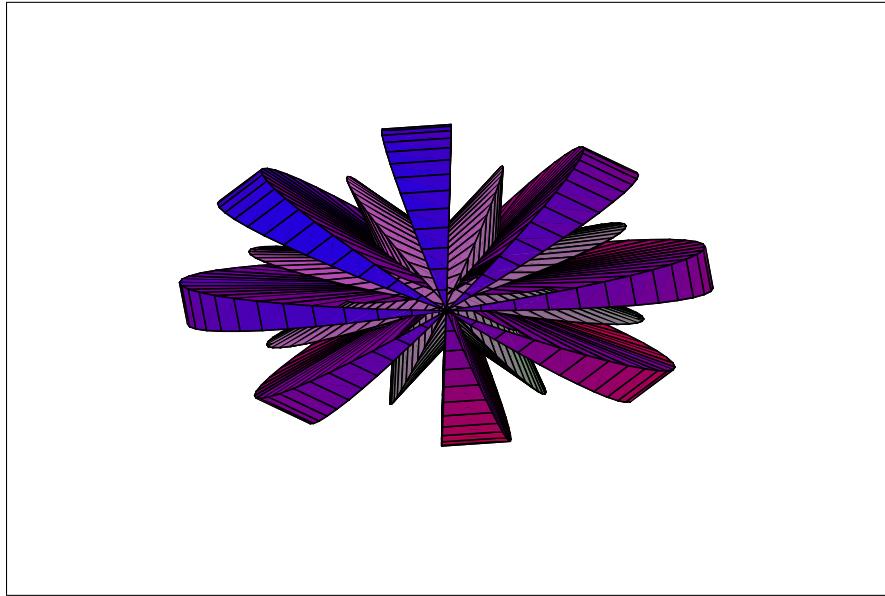
Dej. 12



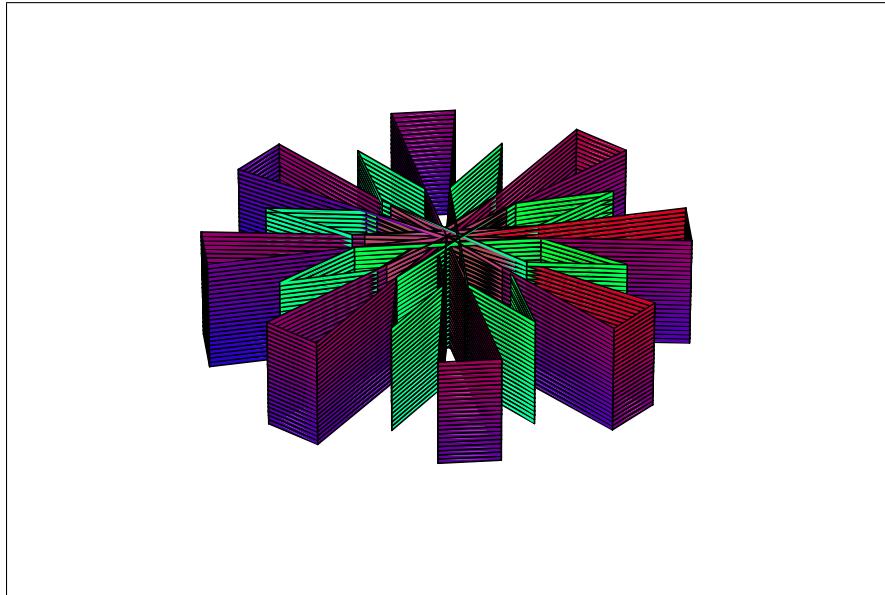
Dej. 11



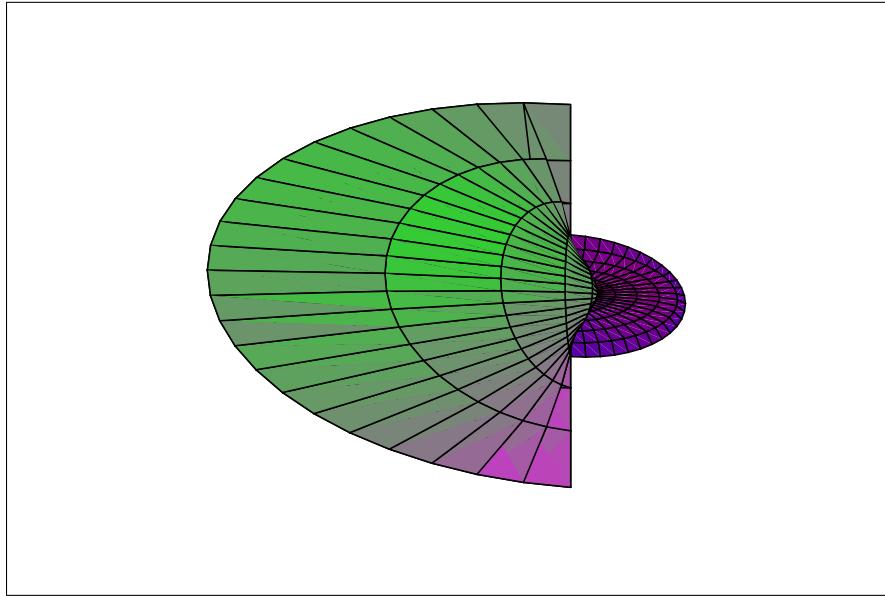
Dej. 10



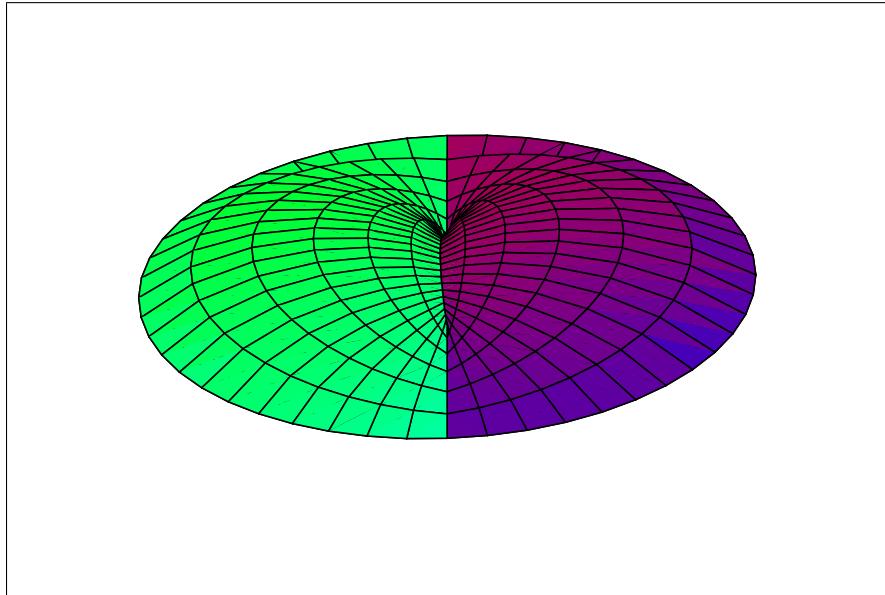
Dej. 9



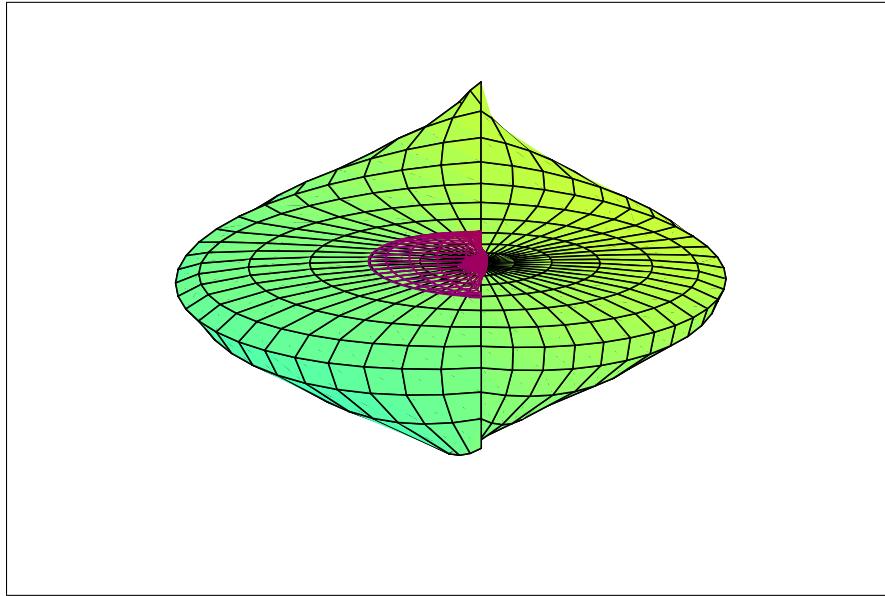
Dej. 8



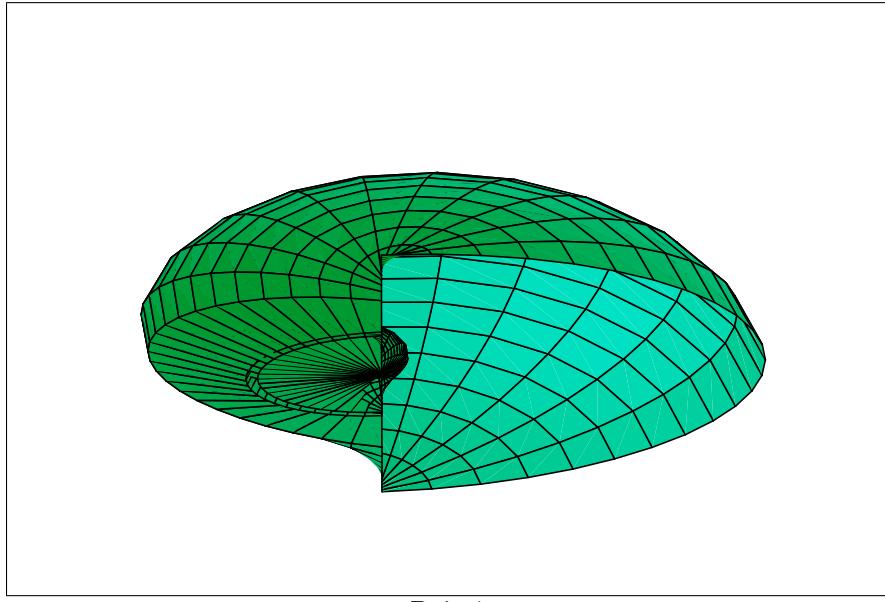
Dej. 7



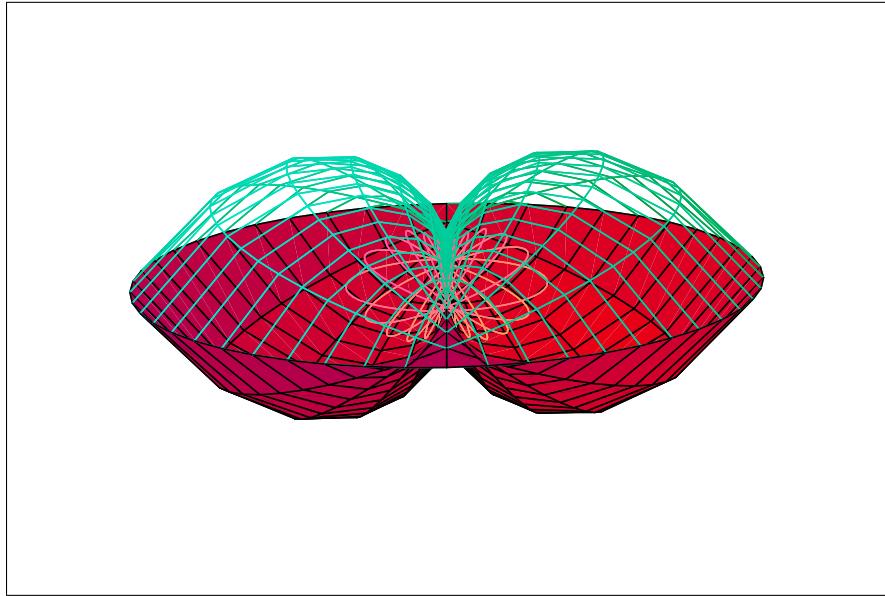
Dej. 6



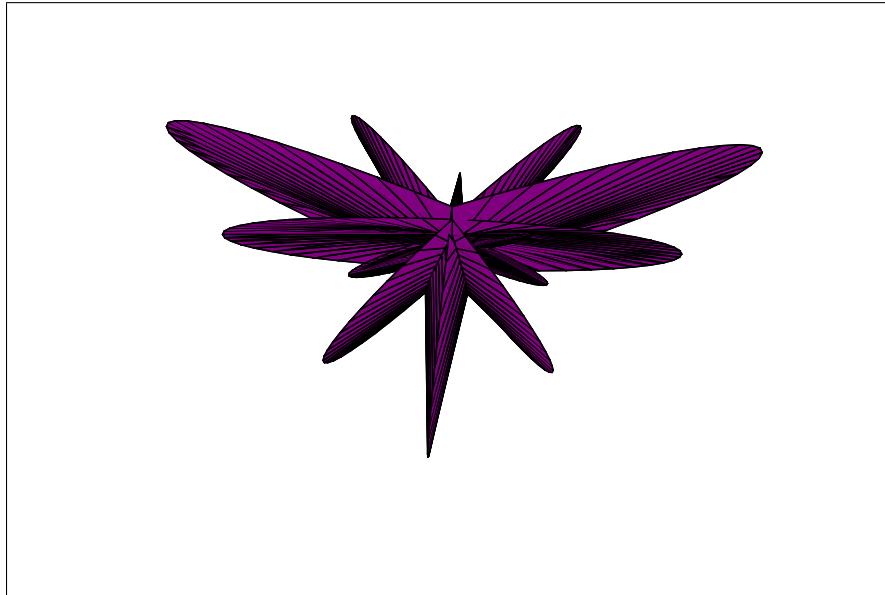
Dej. 5



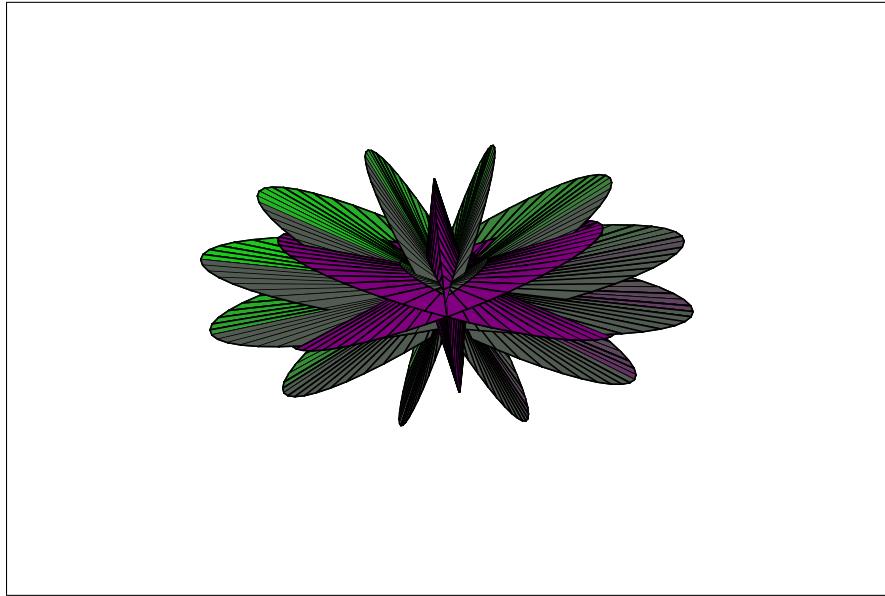
Dej. 4



Dej. 3



Dej. 2



Dej. 1

