バラ曲線の3D化

花柄を描くなら、その基本は「バラ曲線」でした。

半径関数 r(t) を使った 2Dのグラフをベースに、高さ軸 z にも半径関数をそのまま使うと、 3Dのグラフになります。

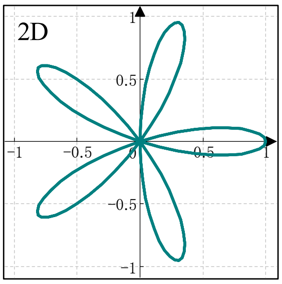
花弁の枚数は、原点を中心として上向きの n 枚と下向きの n 枚です。

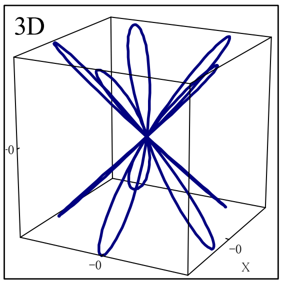
最も単純な r(t)=cos(nt) の場合の n を 1～6 に変化させたグラフを並べておきます。

x(t)=r(t)*cos(t)
y(t)=r(t)*sin(t)
z(t)=r(t)

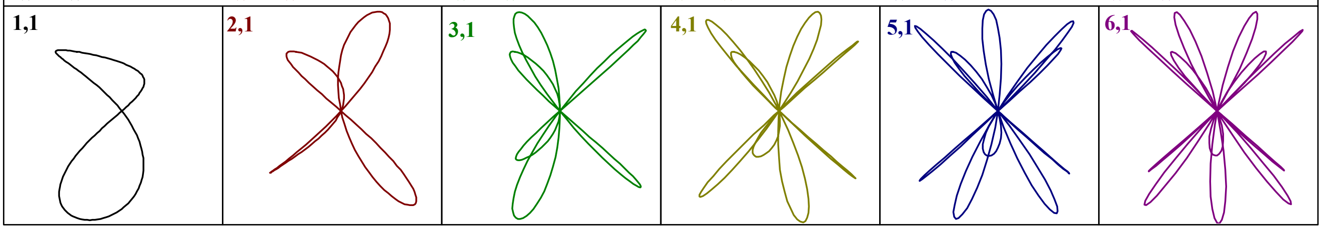
r(t)=cos(nt)
関数定義

n = 5
代入定義



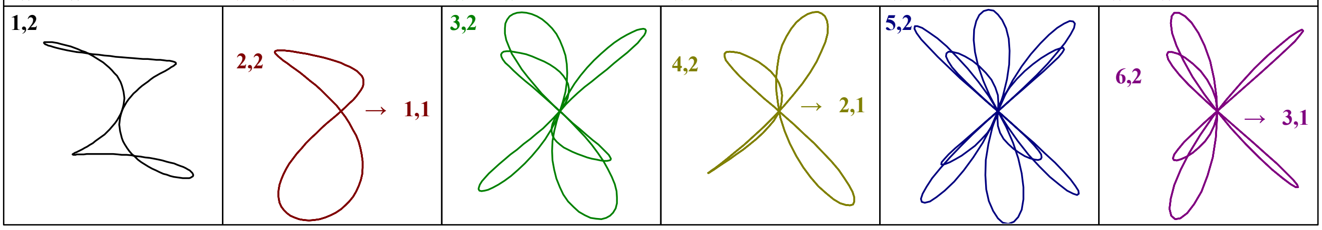


r1(t)=cos(t)	r2(t)=cos(2t)	r3(t)=cos(3t)	r4(t)=cos(4t)	r5(t)=cos(5t)	r6(t)=cos(6t)
x(t)=r1(t)*cos(t) y(t)=r1(t)*sin(t) z(t)=r1(t)	x(t)=r2(t)*cos(t) y(t)=r2(t)*sin(t) z(t)=r2(t)	x(t)=r3(t)*cos(t) y(t)=r3(t)*sin(t) z(t)=r3(t)	x(t)=r4(t)*cos(t) y(t)=r4(t)*sin(t) z(t)=r4(t)	x(t)=r5(t)*cos(t) y(t)=r5(t)*sin(t) z(t)=r5(t)	x(t)=r6(t)*cos(t) y(t)=r6(t)*sin(t) z(t)=r6(t)

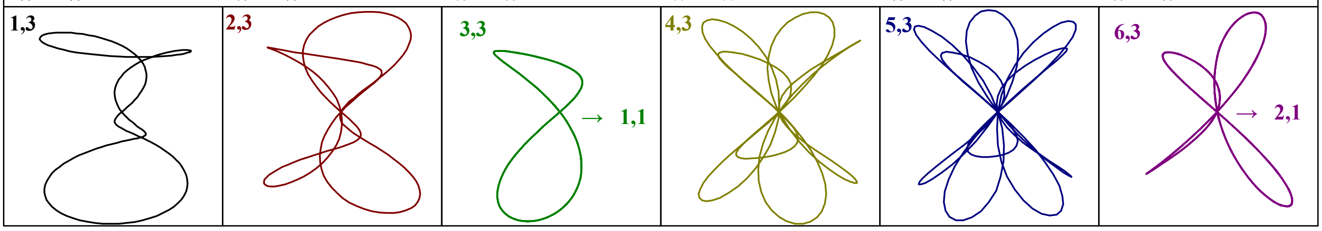


半径関数にかかる cos(mt) や sin(mt) の t にかかる係数 m は周回速度が m倍になり、結果として、花弁の幅が広くなります。
n と m が公約数を持つ場合は、その公約数で割った場合と同じ結果になります。

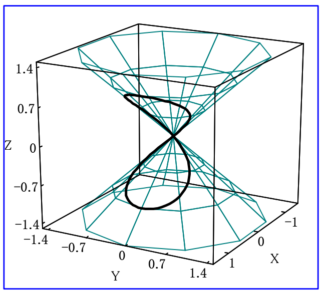
x(t)=r1(t)*cos(2t) y(t)=r1(t)*sin(2t) z(t)=r1(t)	x(t)=r2(t)*cos(2t) y(t)=r2(t)*sin(2t) z(t)=r2(t)	x(t)=r3(t)*cos(2t) y(t)=r3(t)*sin(2t) z(t)=r3(t)	x(t)=r4(t)*cos(2t) y(t)=r4(t)*sin(2t) z(t)=r4(t)	x(t)=r5(t)*cos(2t) y(t)=r5(t)*sin(2t) z(t)=r5(t)	x(t)=r6(t)*cos(2t) y(t)=r6(t)*sin(2t) z(t)=r6(t)

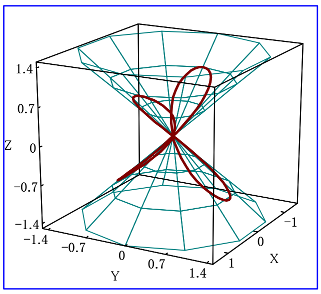


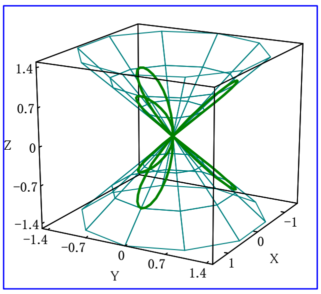
x(t)=r1(t)*cos(3t) y(t)=r1(t)*sin(3t) z(t)=r1(t)	x(t)=r2(t)*cos(3t) y(t)=r2(t)*sin(3t) z(t)=r2(t)	x(t)=r3(t)*cos(3t) y(t)=r3(t)*sin(3t) z(t)=r3(t)	x(t)=r4(t)*cos(3t) y(t)=r4(t)*sin(3t) z(t)=r4(t)	x(t)=r5(t)*cos(3t) y(t)=r5(t)*sin(3t) z(t)=r5(t)	x(t)=r6(t)*cos(3t) y(t)=r6(t)*sin(3t) z(t)=r6(t)



上に並べた線画群は、原点を通過する z = x を、 z 軸を中心に回転して得られる円錐面上を走査したものになっています。





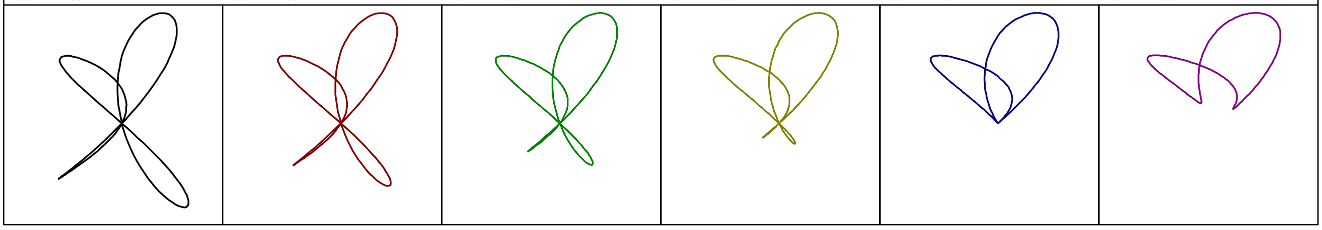


これらのグラフを、3D円錐図形として検討を進めたのです。

半径関数の r(t) を基本形から少し変形した場合を見ておきましょう。 s(t) = a+(1-a)cos(nt) として、a を変化させます。
a ≧ 0.5 では、下向きの花弁が消失します。

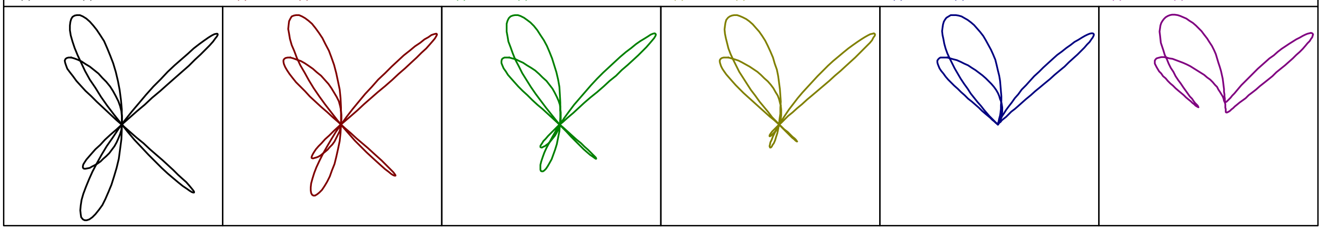
s1(t) = 0.1 + 0.9*cos(2t)
s2(t) = 0.2 + 0.8*cos(2t)
s3(t) = 0.3 + 0.7*cos(2t)
s4(t) = 0.4 + 0.6*cos(2t)
s5(t) = 0.5 + 0.5*cos(2t)
s6(t) = 0.6 + 0.4*cos(2t)

x(t)=s1(t)*cos(t) y(t)=s1(t)*sin(t) z(t)=s1(t)	x(t)=s2(t)*cos(t) y(t)=s2(t)*sin(t) z(t)=s2(t)	x(t)=s3(t)*cos(t) y(t)=s3(t)*sin(t) z(t)=s3(t)	x(t)=s4(t)*cos(t) y(t)=s4(t)*sin(t) z(t)=s4(t)	x(t)=s5(t)*cos(t) y(t)=s5(t)*sin(t) z(t)=s5(t)	x(t)=s6(t)*cos(t) y(t)=s6(t)*sin(t) z(t)=s6(t)



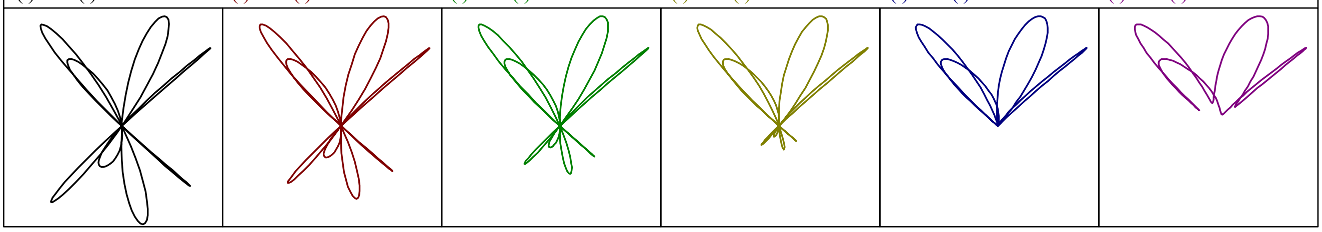
s11(t) = 0.1 + 0.9*cos(3t)
s12(t) = 0.2 + 0.8*cos(3t)
s13(t) = 0.3 + 0.7*cos(3t)
s14(t) = 0.4 + 0.6*cos(3t)
s15(t) = 0.5 + 0.5*cos(3t)
s16(t) = 0.6 + 0.4*cos(3t)

x(t)=s11(t)*cos(t) y(t)=s11(t)*sin(t) z(t)=s11(t)	x(t)=s12(t)*cos(t) y(t)=s12(t)*sin(t) z(t)=s12(t)	x(t)=s13(t)*cos(t) y(t)=s13(t)*sin(t) z(t)=s13(t)	x(t)=s14(t)*cos(t) y(t)=s14(t)*sin(t) z(t)=s14(t)	x(t)=s15(t)*cos(t) y(t)=s15(t)*sin(t) z(t)=s15(t)	x(t)=s16(t)*cos(t) y(t)=s16(t)*sin(t) z(t)=s16(t)



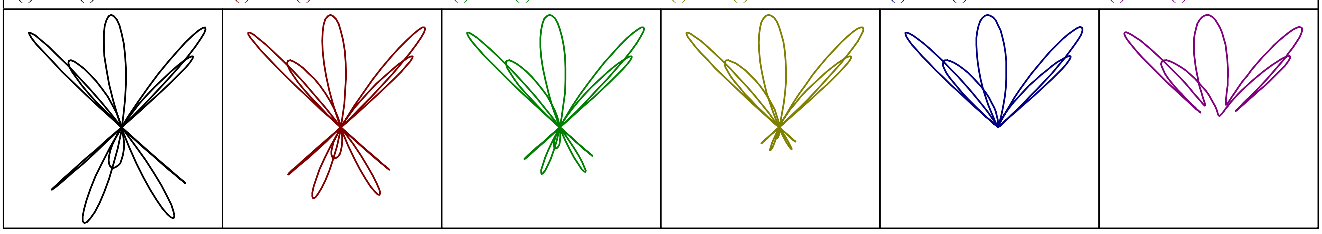
s21(t) = 0.1 + 0.9*cos(4t)
s22(t) = 0.2 + 0.8*cos(4t)
s23(t) = 0.3 + 0.7*cos(4t)
s24(t) = 0.4 + 0.6*cos(4t)
s25(t) = 0.5 + 0.5*cos(4t)
s26(t) = 0.6 + 0.4*cos(4t)

x(t)=s21(t)*cos(t) y(t)=s21(t)*sin(t) z(t)=s21(t)	x(t)=s22(t)*cos(t) y(t)=s22(t)*sin(t) z(t)=s22(t)	x(t)=s23(t)*cos(t) y(t)=s23(t)*sin(t) z(t)=s23(t)	x(t)=s24(t)*cos(t) y(t)=s24(t)*sin(t) z(t)=s24(t)	x(t)=s25(t)*cos(t) y(t)=s25(t)*sin(t) z(t)=s25(t)	x(t)=s26(t)*cos(t) y(t)=s26(t)*sin(t) z(t)=s26(t)

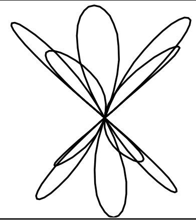
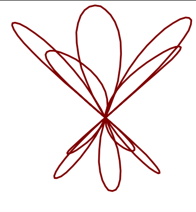
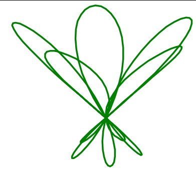
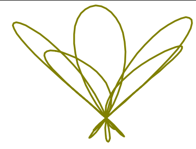
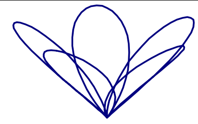
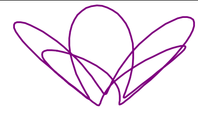


s31(t) = 0.1 + 0.9*cos(5t)
s32(t) = 0.2 + 0.8*cos(5t)
s33(t) = 0.3 + 0.7*cos(5t)
s34(t) = 0.4 + 0.6*cos(5t)
s35(t) = 0.5 + 0.5*cos(5t)
s36(t) = 0.6 + 0.4*cos(5t)

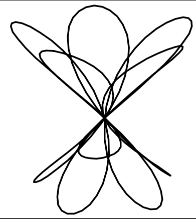
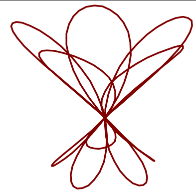
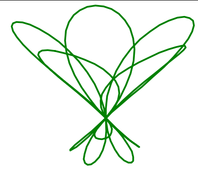
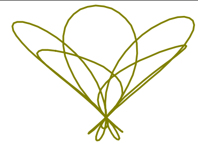
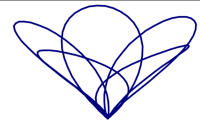
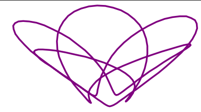
x(t)=s31(t)*cos(t) y(t)=s31(t)*sin(t) z(t)=s31(t)	x(t)=s32(t)*cos(t) y(t)=s32(t)*sin(t) z(t)=s32(t)	x(t)=s33(t)*cos(t) y(t)=s33(t)*sin(t) z(t)=s33(t)	x(t)=s34(t)*cos(t) y(t)=s34(t)*sin(t) z(t)=s34(t)	x(t)=s35(t)*cos(t) y(t)=s35(t)*sin(t) z(t)=s35(t)	x(t)=s36(t)*cos(t) y(t)=s36(t)*sin(t) z(t)=s36(t)



ここでは、同じ５弁花で、花弁の幅が２倍の場合を見ておきます。 s31(t) などの関数定義は同じものを使い、グラフの x(t) 及び y(t) の変化速度を倍増します。

x(t)=s31(t)*cos(2t) y(t)=s31(t)*sin(2t) z(t)=s31(t)	x(t)=s32(t)*cos(2t) y(t)=s32(t)*sin(2t) z(t)=s32(t)	x(t)=s33(t)*cos(2t) y(t)=s33(t)*sin(2t) z(t)=s33(t)	x(t)=s34(t)*cos(2t) y(t)=s34(t)*sin(2t) z(t)=s34(t)	x(t)=s35(t)*cos(2t) y(t)=s35(t)*sin(2t) z(t)=s35(t)	x(t)=s36(t)*cos(2t) y(t)=s36(t)*sin(2t) z(t)=s36(t)
					

同様に５弁花で、花弁の幅が 3倍の場合です。 グラフの x(t) 及び y(t) の変化速度を3倍にします。

x(t)=s31(t)*cos(3t) y(t)=s31(t)*sin(3t) z(t)=s31(t)	x(t)=s32(t)*cos(3t) y(t)=s32(t)*sin(3t) z(t)=s32(t)	x(t)=s33(t)*cos(3t) y(t)=s33(t)*sin(3t) z(t)=s33(t)	x(t)=s34(t)*cos(3t) y(t)=s34(t)*sin(3t) z(t)=s34(t)	x(t)=s35(t)*cos(3t) y(t)=s35(t)*sin(3t) z(t)=s35(t)	x(t)=s36(t)*cos(3t) y(t)=s36(t)*sin(3t) z(t)=s36(t)
					

かなり花らしい感じになりましたが、かっちりし過ぎて面白みが足りませんね。

何かしらの調味料を加えないと。

また、下向きにはみ出した花弁の処理が次の問題になります。