Introduction to Geometrical Optics – a 2D ray tracing Excel model for spherical mirrors – Part 5

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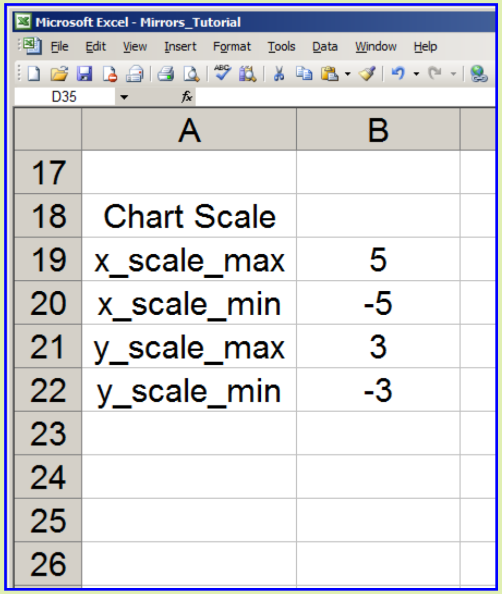
- In the previous section we derived the formulas for coordinates of the end point of the reflected ray (so that it falls not too far away from the visible region of the chart) and we developed a user defined VBA function, Chart_Reflect(), to calculate the x-y coordinates of that point.
- This section continues by using both functions (Reflect() and Chart_Reflect()) in the spreadsheet to define each of the 21 rays in a table and then display them on the same chart with the mirror.

Using the Chart_Reflect() custom VBA function in the spreadsheet:

- Copy the current worksheet and rename the copy "Tutorial_5"
- Insert the chart maximum scale coordinates:
- Range A18:A22 contains labels and range B19:B22 contains constants equal to the maximum and minimum values of both x and y axes.
- For later convenience let's rename few cells:
  - => name B19 "x_scale_max"
  - => name B20 "y_scale_min"
  - => name B21 "y_scale_max"
  - => name B22 "y_scale_min"



	A	B
17		
18	Chart Scale	
19	x_scale_max	5
20	x_scale_min	-5
21	y_scale_max	3
22	y_scale_min	-3
23		
24		
25		
26		

Type in the active formulas for both the incident and the reflected rays:

Description:

- The incident and reflected ray formulas will be inserted in columns E, F, G and H.
- Column E will contain the ray number.
- Columns F and G will contain the x and y coordinates of three points: the light source, the incidence pint of the mirror (common to both the incident and the reflected rays) and the terminal point of the reflected ray.
- Column H will contain the angle of the reflected ray and it will be used to calculate the terminal point of the reflected ray.

Microsoft Excel - Mirrors_Tutorial

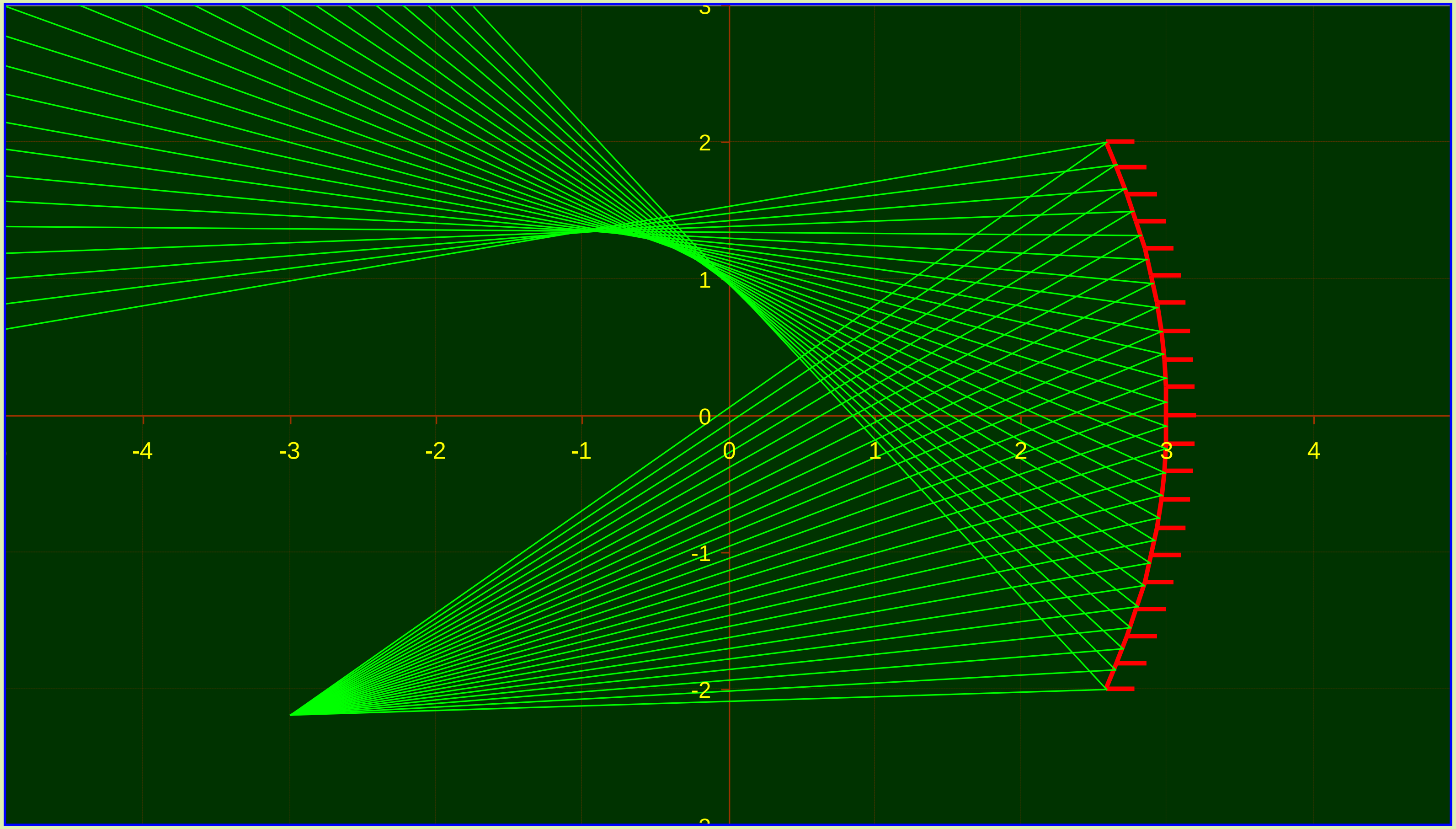
	D	E	F	G	H
40					
41		Ray_index	x	y	alpha_e
42		0	-3	-2.18382	
43			3.877501	-2.5	-1.3962
44			3.789307	-3	
45					
46		1	-3	-2.18382	
47			3.736276	-2.3126	-1.25203
48			3.509421	-3	
49					
50		2	-3	-2.18382	
51			3.616043	-2.1328	-1.11705
52			3.19312	-3	
53					
54		3	-3	-2.18382	
55			3.512441	-1.95881	-0.98896
56			2.827546	-3	
57					
58		4	-3	-2.18382	
59			3.422474	-1.78922	-0.86614
60			2.392964	-3	
61					

Implementation:

- Range E41:H41 contains labels.
- E42: "=0", F42: "=x_L", G42: "=y_L"
- F43: "=Reflect(xL,yL,xM,yM,alpha_min+E42*delta_alpha,Radius)" then select F43:H43 and holding F2 – down hit Ctrl+Shift+Enter
- F44: "=chart_reflect(x_scale_max,x_scale_min,y_scale_max,y_scale_min,F43,G43,H43)" then select F44:G44 and holding F2 down hit Ctrl+Shift+Enter
- E46: "=E42+1"
- Copy range F42:H44 into range F46:H48
- Copy range E46:H49 into range E50:H141 and we finished

Plot the incident and the reflected rays:

- Select the chart => Right click the selected chart => Source data => Series => Select the "Incident Beam" series, rename it "Incident & Reflected Beam" and readjust the series range to F42:G140
- Make sure to double click the plotting area and change the color to a uniform color (not some fill effects containing a mixture of two colors). Fill effects will slow down the model.



You can further experiment with the model by adjusting not only the mirror diameter and radius of curvature, but also the distance and angle of the incident beam (a positive radius of curvature means a convex mirror).

to be continued…