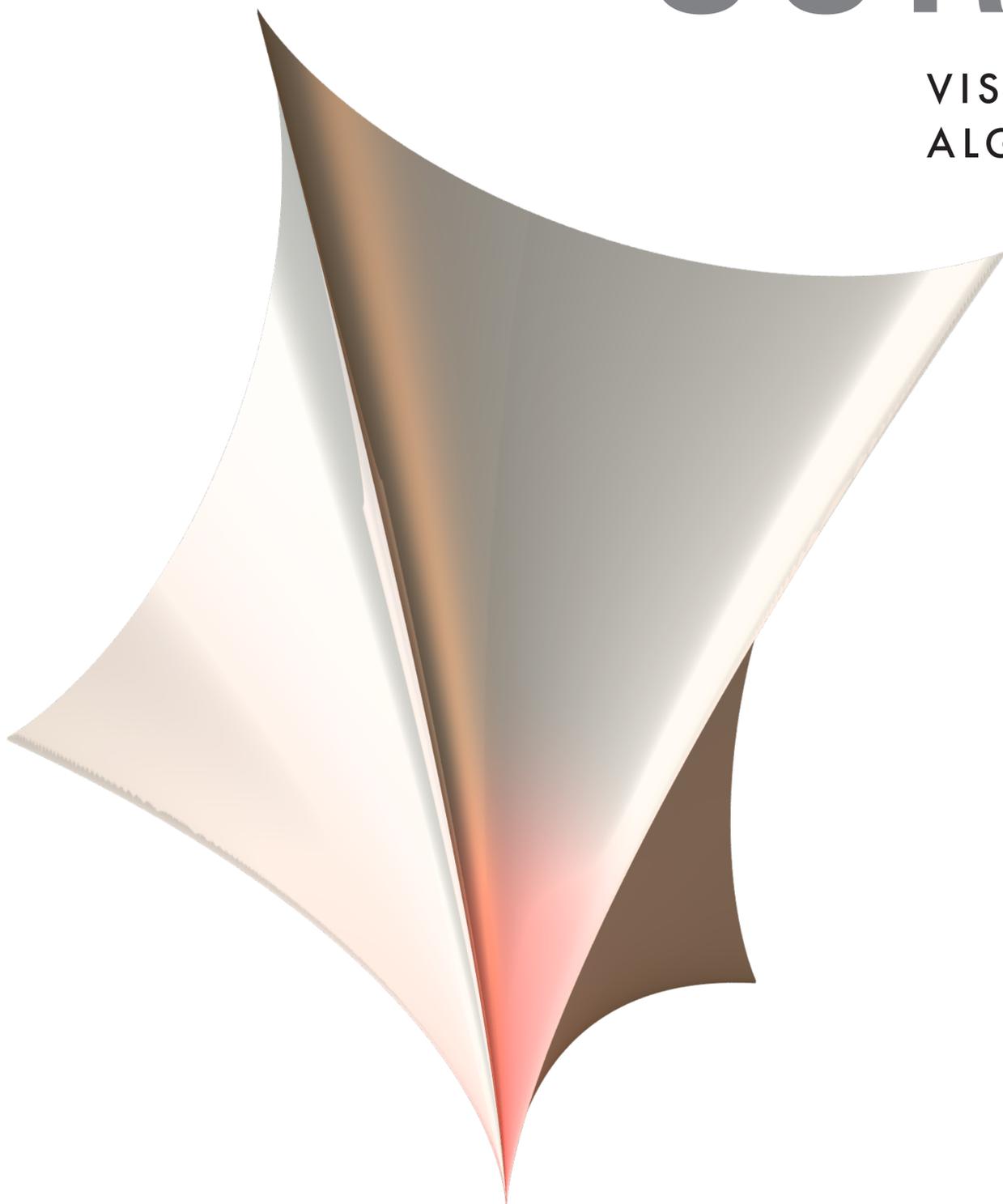


SURFER₂₀₀₈

VISUALIZATION OF
ALGEBRAIC SURFACES



OVERVIEW

With SURFER you can experience the relation between formulas and forms, i.e. mathematics and art, in an interactive way. You can enter simple equations that produce beautiful images, which are surfaces in space. Mathematically, the program visualizes real algebraic geometry in real-time. The surfaces shown are given by the zero set of a polynomial equation in 3 variables. SURFER 2008 is based on the Surf program and was developed for the IMAGINARY exhibition planned by the Mathematisches Forschungsinstitut Oberwolfach for the Year of Mathematics 2008 in Germany.

BRIEF INSTRUCTION

INTRODUCTION

With SURFER you can create algebraic surfaces through equations. The polynomial equations are given in the variables x , y and z . All points in space that solve the equation are displayed and form the surface. As an example look at $x^2+y^2+z^2-1=0$, the equation of a sphere. You can easily see that the point $(0,0,0)$ is not on the sphere while the points $(1,0,0)$, $(0,1,0)$ and $(0,0,-1)$ for example solve the equation. Note that a polynomial is given by variables with natural exponents, real coefficients and their multiplication and sum.

www.imaginary.org/program/surfer-2008

SYSTEM REQUIREMENTS

Windows 2000/XP/Vista/Win7/Ubuntu 10.04, 256MB RAM, CPU 1.4 GHz or higher. Screen resolution 1024 x 768 or higher.

INSTALLATION (WINDOWS)

Launch the file `surfer-setup.exe` and follow the installation instructions. Surfer requires the following runtime components which are installed automatically: Microsoft Visual Studio 2005 SP1, GTK+ and gtkmm.

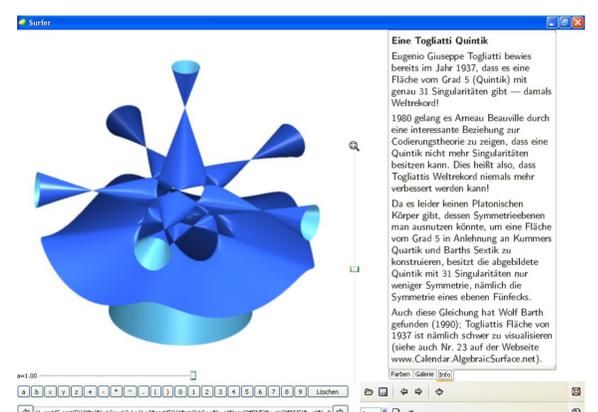
INSTALLATION (UBUNTU)

Launch the file `surfer.deb` and the program will be installed. It was tested for Ubuntu 10.4 and should also run in newer versions.

Note that the program Surf will be installed along SURFER. The source code and license information can be found on the SURFER page.

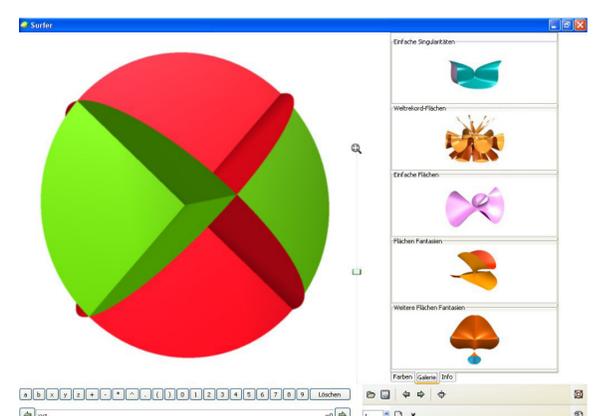
1. ENTRY OF POLYNOMIAL

The polynomial in the three variables x , y and z can be entered in the text field at the bottom left. If the formula is syntactically incorrect, a red exclamation mark (!) pops up on the right hand side of the text field. The surface, i.e. the real zeros of the polynomial, are displayed immediately. Each surface is first shown in low resolution and after a short time of calculation in high resolution.



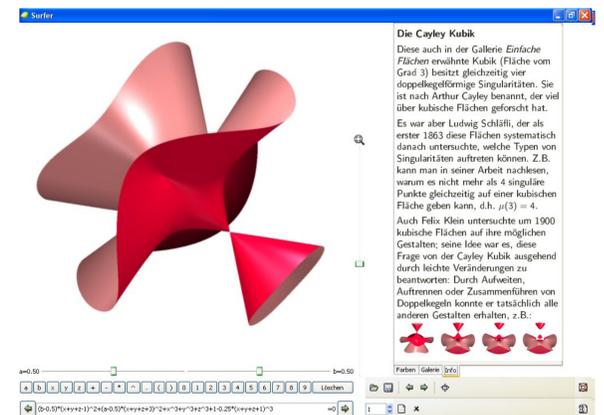
2. ROTATION OF THE SURFACE

While holding down the left mouse button at the center of the image, the surface can be rotated. During the rotation the surface is displayed in low resolution. When the button is released it will be shown in high resolution - after a short time of calculation.



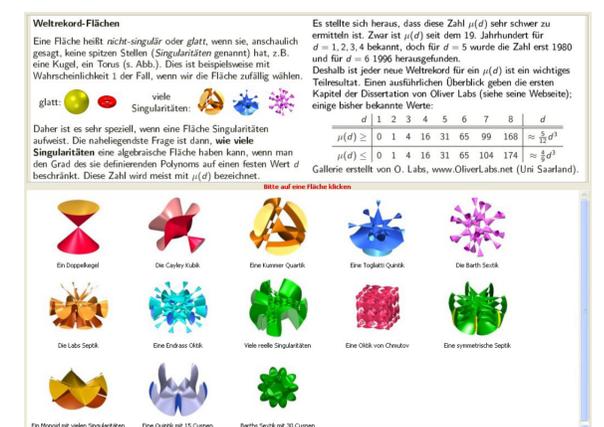
3. ZOOMING

With the zoom bar (magnifying glass) at the right of the display window you can zoom in or zoom out by changing the radius of the invisible sphere intersecting the surface. The surface is always displayed in the same overall size.



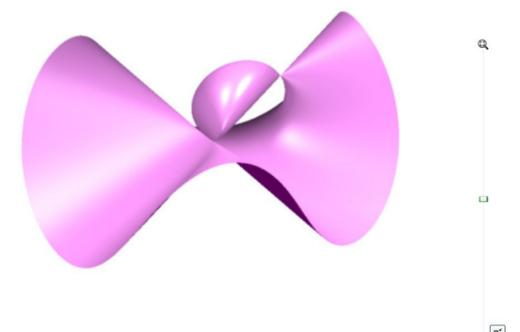
4. ENTRY OF PARAMETERS

The parameters a , b , c and d can be used in the text field. When using them, sliders automatically appear to change the parameters in a given range (for example between 0 and 1). The parameters can easily be changed with the mouse. The changed surface is displayed immediately.



5. COLOURS

Under the menu item Colours, a specific colour can be assigned to the exterior or interior side of the surface. The colours are selected from a quadratic pool of colours.

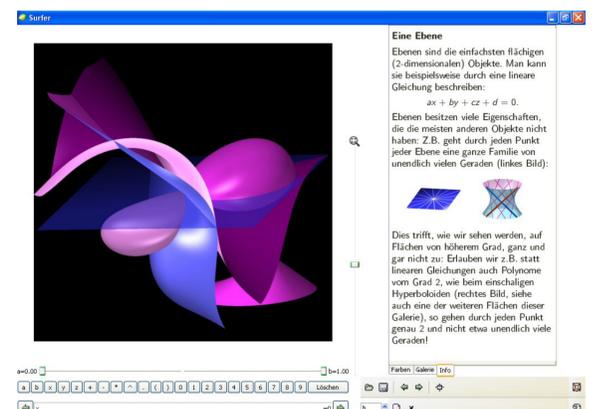


6. GALLERY AND INFORMATION

Under the menu item Gallery, a great choice of surfaces is available to view with options to change given parameters. Many surfaces are provided with additional information that is indicated under the menu item Info upon selection of a surface. The two little green arrows serve to select the next surface of the chosen gallery.

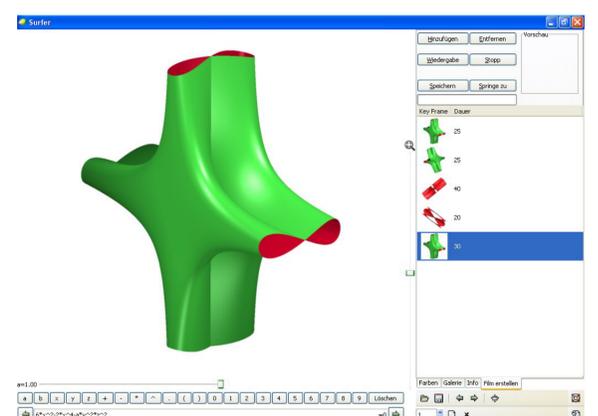
7. FULL SCREEN

The button Full Screen (to the right of the green arrows) allows to switch into fullscreen which shows the window fullscreen sized. The fullscreen mode allows zooming, changing parameters and switching back to standard mode by clicking the button in the bottom right corner.



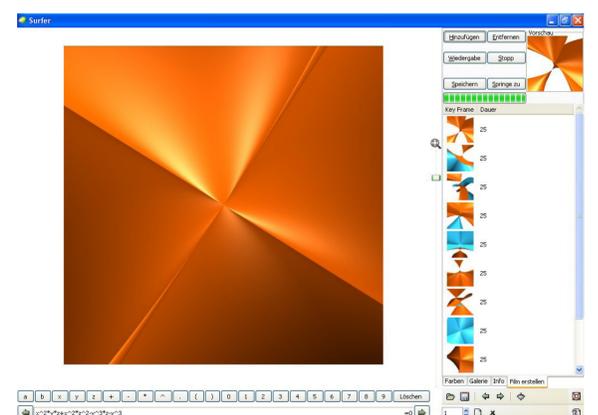
8. SAVING AND LOADING IMAGES

The buttons Save and Load (left of the green arrows) allow saving the surface as an image in png-format or loading / saving as a surfer file in pic-format. The surfer file includes all settings (rotation, zoom, colours, special settings, etc.).



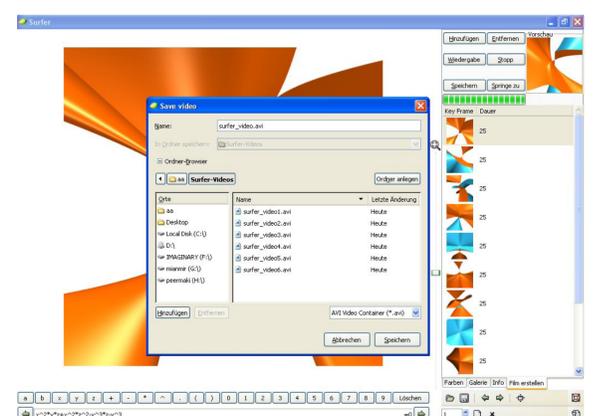
9. SEVERAL SURFACES

SURFER is able to display 8 algebraic surfaces at the same time. New surfaces are added and automatically numbered with the button New Surfaces (Page Symbol). The colour and expert settings refer to the surface selected. The surfaces are removed with the button Delete Surface (X Symbol).



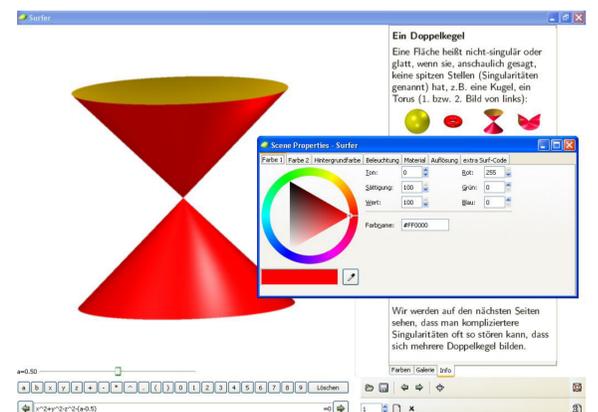
10. CREATING ANIMATIONS

Under the menu item Create Film, videos of algebraic surfaces can be generated. Changes of surface rotation, parameters and colours can be defined. The resulting image sequences are saved as videos.



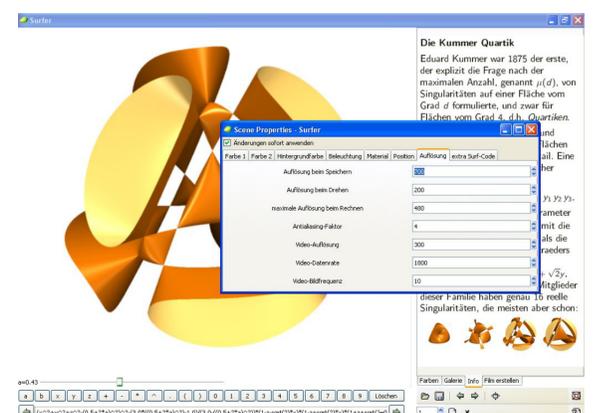
10.1 ANIMATION BY KEYFRAMES

The animation is generated by several keyframes collected in a list. A keyframe includes the rotation of the surface, the colour, the zoom level, and the parameters. To generate the animation, the images between the keyframes are automatically calculated by interpolating all components of the keyframes, e.g. position or colour. The number of images between the keyframes is defined on the right side of the keyframe. Keyframes are added to the list with the button Add.



10.2 CHANGING AND DELETING KEYFRAMES

The position of the keyframes can be dragged with the mouse. To jump to a given keyframe, you highlight it and then press the Jump to button. By pressing the Add button again, keyframes can be copied to generate e.g. a video which at the end passes into the beginning. With the Remove button or the remove key a highlighted keyframe is deleted.



10.3 CREATING AND SAVING ANIMATIONS

The animation is calculated with the Play button and displayed in the video preview window on the right. The preview can be stopped with Stop. The animation can be saved with Save (in case of change it will be calculated anew, if necessary). The videos are generated in the resolution indicated. It is 300x300 pixel by default, changes are possible in the expert menu.

11. EXPERT MENU SETTINGS

The window with the expert menu is opened via the Settings button at the bottom right.

11.1 COLOUR DETAILS AND BACKGROUND

The first three menus allow to accurately set the exterior/interior surface and the background colour.

11.2 LIGHTING AND MATERIAL

Under the menu item Lighting, up to 9 light sources are defined (position, colour, intensity). The material settings (transparency, brilliance, reflection etc.) are adjusted under the menu item Material.

11.4 POSITION OF IMAGES

Under the menu item Position, the rotation of the image around the x, y and z axis can be accurately set.

11.5 RESOLUTION OF IMAGES AND VIDEOS

Under the menu item Resolution, the pixel resolution for the saved and displayed images and the videos is defined. The maximum resolution is 3000 pixels. Depending on the image complexity, it can take some minutes to compute the image and save it. In addition, the compression (data rate) and image frequency for videos can be defined.

11.6 SURF CODE

The menu item Special Surf Code allows the definition of variables and additional expert settings (iterations, zero finder, number parameters, etc.) in the Surf program which is responsible for the computation of the surface image. You will find details on Surf in the documentation under <http://surf.sourceforge.net>.

12. SURFER IN SCHOOL

SURFER has been used in interactive teaching. Please visit our website www.imaginary.org for ideas to use SURFER at school

13. SURFER IMAGE COMPETITIONS

We collect nice, creative, interesting and funny images generated with Surfer. Example competitions with prizes can be found on our website. Please send us your creations!

14. SURFER IN MUSEUMS OR AT EXHIBITIONS

For detailed information and advice on how to use SURFER as an interactive installation in museums or at exhibitions, please refer to the technical installation manual. It contains hardware specifications and special settings for full screen mode or printing options.

DOWNLOAD UND CONTACT

www.imaginary.org/program/surfer-2008

surfer@imaginary.org

SURFER TEAM

SURFER 2008 is a project of the Mathematisches Forschungsinstitut Oberwolfach and the Technical University of Kaiserslautern. SURFER is part of the travelling exhibition IMAGINARY by the Mathematisches Forschungsinstitut Oberwolfach.

Direction: Gert-Martin Greuel

Programming: Henning Meyer (Linux version, Surf) and Christian Stussak (Windows conversion, Java version, Surf)

Concept/Galleries: Oliver Labs

Support: Felix Riemann

Concept/Coordination: Andreas Matt

Surfer is based on the Surf program by Stephan Endrass and others.

surf.sourceforge.net