Guidance for

Overview of Modern Mathematics (現代数学概説) Overview of Mathematical Sciences (数理科学概説)

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April 6, 2011

http://www.math.sci.hokudai.ac.jp/~furuhata/ed/lecture.html

Overview of Modern Mathematics

1. Minimal surfaces — mathematical aspects of soap films

   極小曲面 — 石鹸膜の数学

   FURUHATA Hitoshi (古畑　仁)

2. Magic squares from the modern mathematical point of view

   現代数学から見た魔方陣

   SHIBUKAWA Yoichi (澁川 陽一)

Overview of Mathematical Sciences

3. Nonlinear phenomena and Chaos

   非線形現象とカオス

   SAIKI Yoshitaka (斉木 吉隆)

4. Qualitative properties to nonlinear partial differential equations

   非線形偏微分方程式の定性的性質

   TAKAOKA Hideo (高岡 秀夫)

GRADING PLAN

[1] Modern Mathematics = Max { "FURUHATA", "SHIBUKAWA" }

[1] Mathematical Sciences = Max { "SAIKI", "TAKAOKA" }

Attendance will be very important.

Each grading plan is presented on the first time.

TENTATIVE SCHEDULE

April 6, 13, 20, 27,	FURUHATA
May 11, 18, 25, June 1,	SHIBUKAWA
June 8, 15, 22,	SAIKI
June 29, July 6, 13, 20,	TAKAOKA

Minimal surfaces — mathematical aspects of soap films

FURUHATA Hitoshi

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GRADING PLAN

Attendance + Report

e.g.

$4 + 1 \longrightarrow$ better than "Passing"

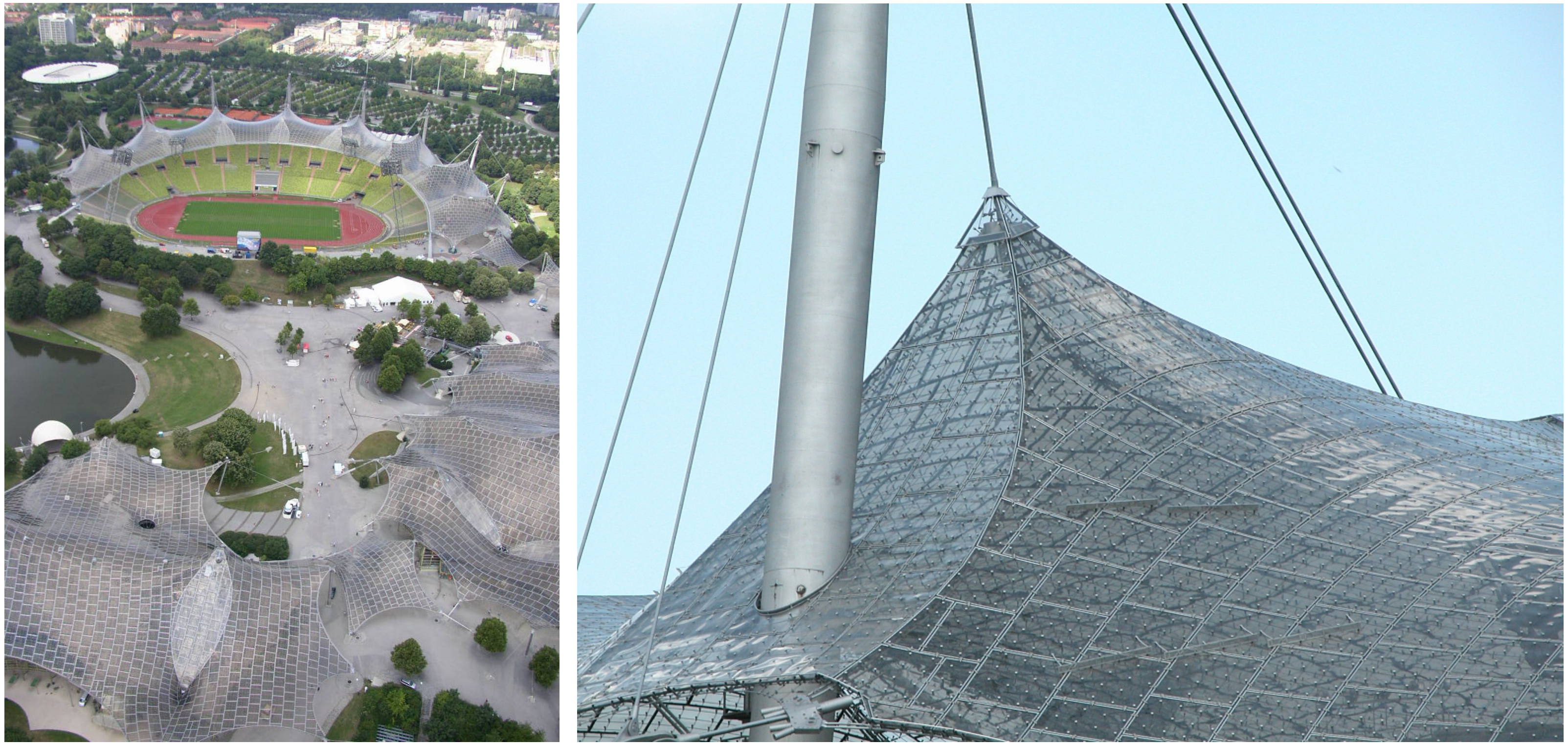
$3 + 4 \longrightarrow$ "Excellent"

Deadline of Report: June 1, Report Box: 3F of Building 3

Exercises will be presented in class.

http://en.wikipedia.org/wiki/Soap_bubble


北海道大学
理学部同窓会誌
50
平成20年度　2008



Olympic Stadium (Munich) by Frei Otto
http://en.wikipedia.org/wiki/Frei_Otto

Touching Soap Films

An Introduction to Minimal Surfaces
By Hermann Karcher and Konrad Polthier

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Crystallographic Models and Zeolithes

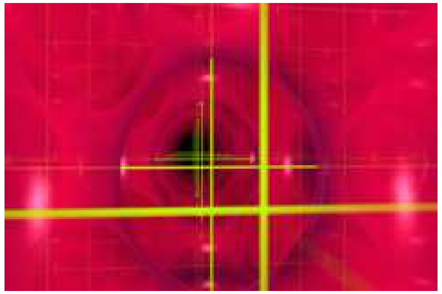

Fig 5. Inside a triply periodic minimal surface of Schwarz. with skeletal graph.

Contrary to a soap bubble which encloses under pressure a certain volume of air, a soap film is in equilibrium and has the same pressure on both of its sides. Infinite soap films (without self intersections) therefore divide space into two regions and can be seen as the interface between them. This natural separating property can be observed in a number of physical models: a group in Amherst, Massachusetts under the polymer chemist Edwin L. Thomas have made experiments about the equilibrium state of two mixed long-chained polymers.

Different to oil and water which separate one above the other in a clean way, these polymers generate complicated interweaving 3-dimensional structures. Since the investigators had no visible spatial model for the common boundary surface of these two components, they were at first unable to interpret the scanning electron projection micrographs they obtained. A comparison with images of triply periodic minimal surfaces revealed an astounding similarity between these two kinds of surfaces that had arisen in such very different ways and helped for a better understanding of those structures.

Zeolithe crystals consist of a skeleton of silicon, aluminum and oxygen atoms, and the remaining space is filled with crystal water. During careful heating the water evaporates and leaves a highly porous crystal skeleton which is used as an ion exchanger, used as a molecular sieve, and used during oil cracking. It turns out that the tetrahedral building units of sodalith has the form of a minimal surface of Schwarz. Similar connections were found for other zeolithes.

An amazing similarity was found during the investigation of electric fields in crystal grids between minimal surfaces and zero potential fields where point charges are located at the grid points of the crystal. In these studies minimal surfaces seem to play merely the role of prototypes of potential spatial structures. The real world applications are usually more complicated than the clean mathematical models.

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References

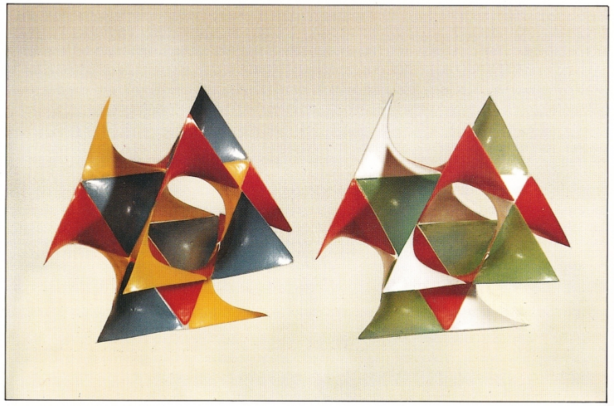
[1] A. Gray, E. Abbena and S. Salamon, *Modern differential geometry of curves and surfaces with Mathematica*, 3rd ed, Champman & Hall/CRC, 2006

[2] R. Osserman, *A survey of minimal surfaces*, Dover Publ., 1986

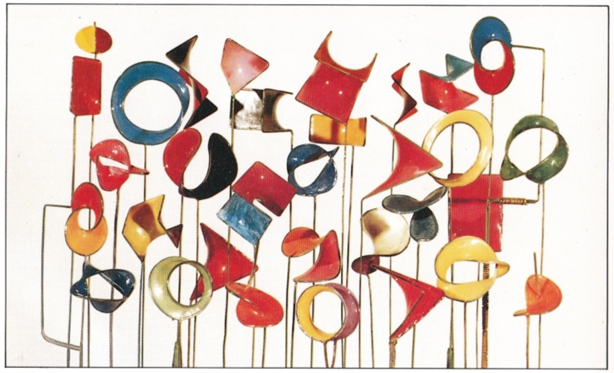
[3] J.C.C. Nitsche, *Lectures on minimal surfaces Vol.1*, Cambridge Univ. Press, 1989

[4] `http://www.math.sci.kobe-u.ac.jp/~fujimori/min_surf/min_surf.html`

[5] `http://page.mi.fu-berlin.de/polthier/booklet/`



Two parts of Schwarz's triply periodic minimal surface; see §279*



Garden of minimal surfaces*

* *Models (and photographs) by the author and C. D. Nitsche*

LECTURES ON MINIMAL SURFACES

Volume 1

Introduction, fundamentals, geometry and basic boundary value problems

JOHANNES C. C. NITSCHE
University of Minnesota, Minneapolis

The right of the University of Cambridge to print and sell all manner of books was granted by Henry VIII in 1534. The University has printed and published continuously since 1584.

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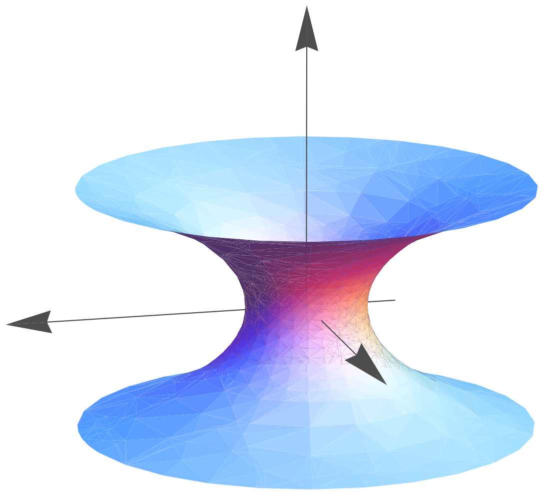
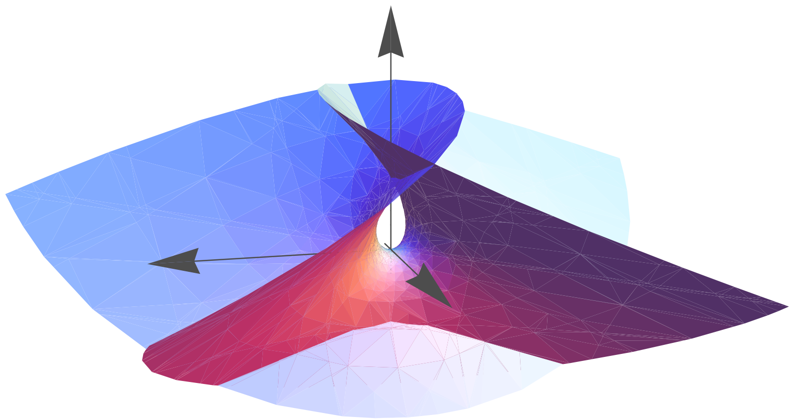


Catenoid



Enneper's surface

http://www-history.mcs.st-andrews.ac.uk/Biographies/Euler.html
http://www.enneper.name/Alfred_Enneper.htm
(1830-1885)

1. Check them from various viewpoints!
2. Go to the gallery of surfaces!