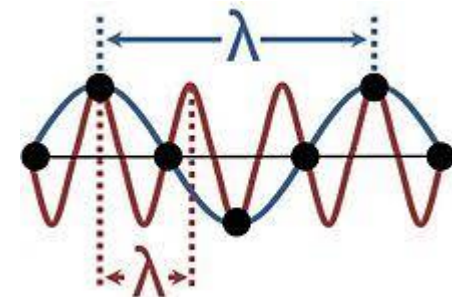
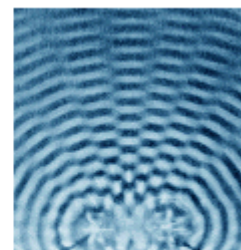
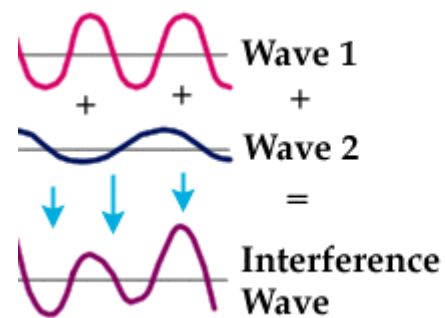
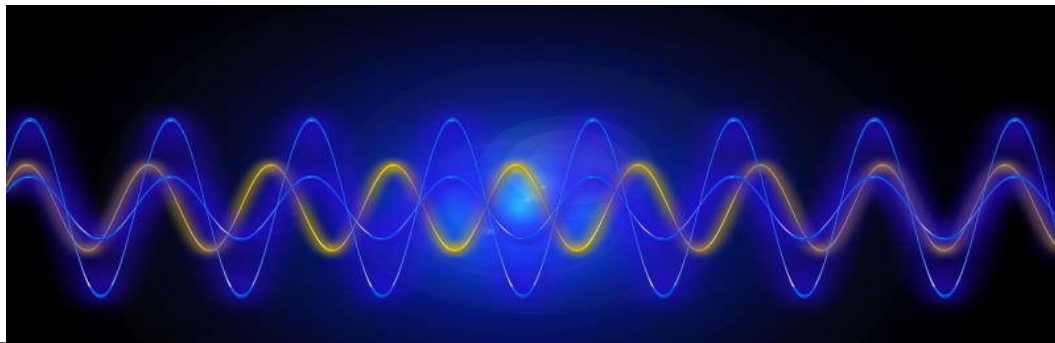


Spectraalanalyse ook voor alien signalen

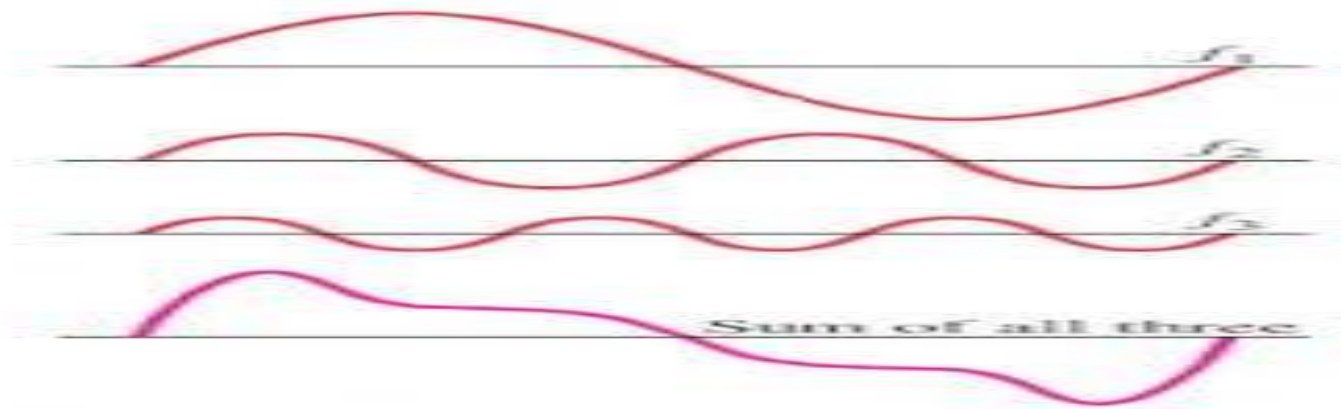
- Het ontstaan
- De huidige aanpak
- Uitbreiding
- Zelfbouwset



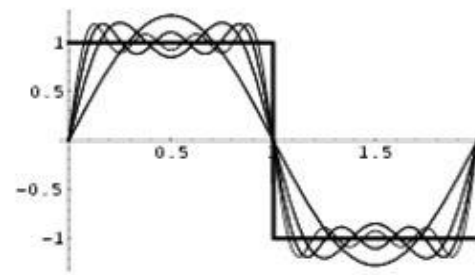
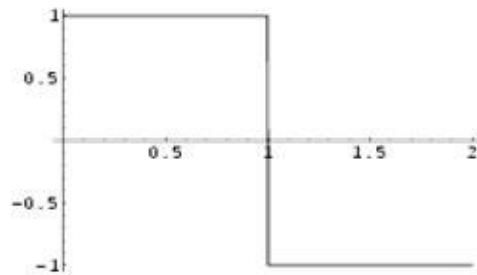
Standing waves on a string.gif



The interference of water waves coming from two sources.

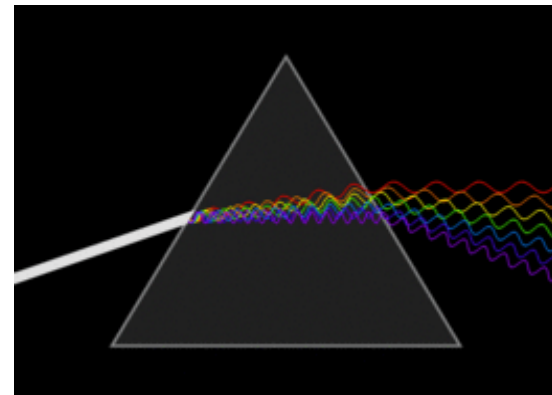
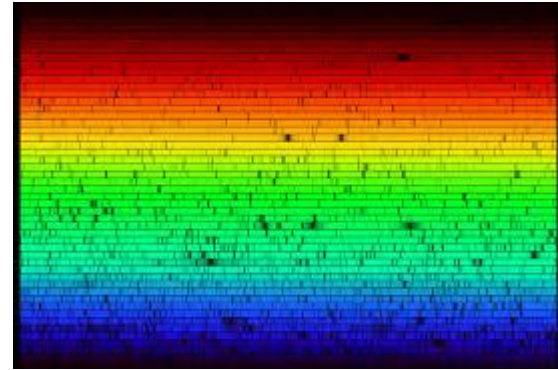
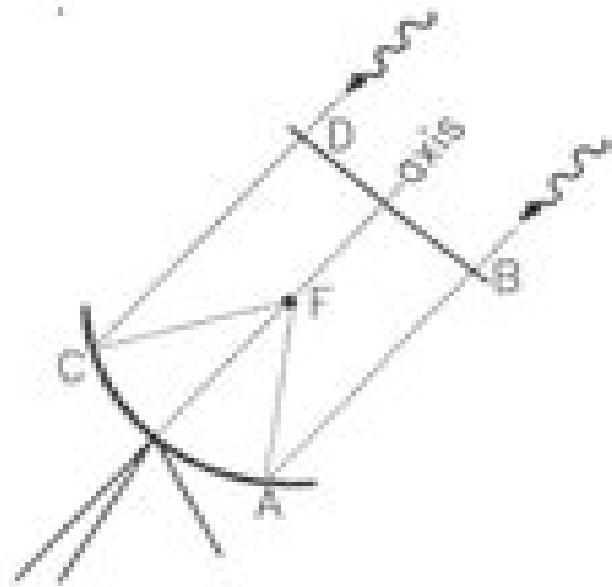


$$f(x) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos \frac{n\pi x}{L} + b_n \sin \frac{n\pi x}{L} \right)$$



$$f(x) = \frac{4}{\pi} \left(\sin \pi x + \frac{1}{3} \sin 3\pi x + \frac{1}{5} \sin 5\pi x + \dots \right)$$

<http://mathworld.wolfram.com/FourierSeriesSquareWave.html>

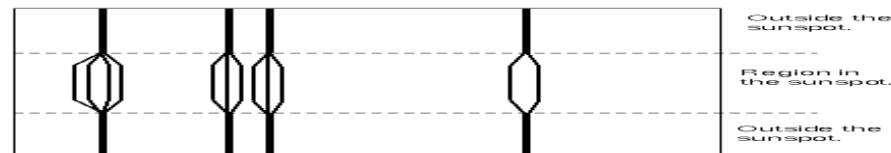
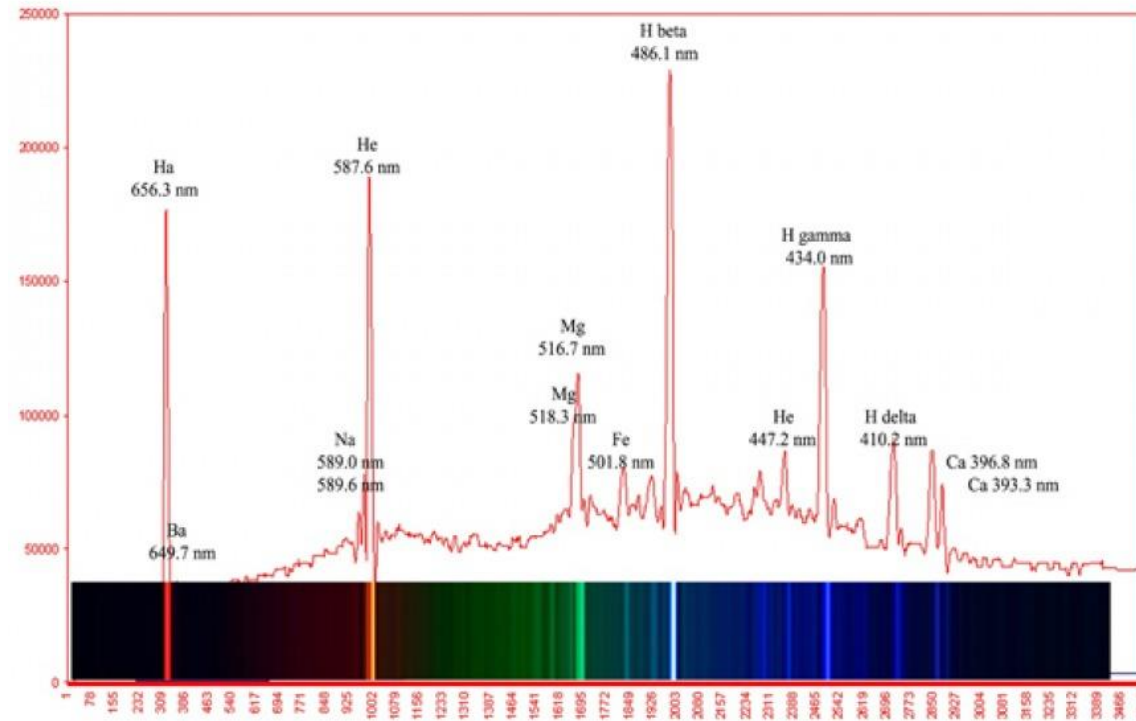


Spectra denken we ons dus continue in.

Daarom zijn er voor de niet continue realiteit Short Time Fourier Transform, Windowed Fourier Transform, etc. bedacht.

Meestal is er continuïteit en duid-baarheid (bekende materie):

The Solar Chromosphere Spectrum (Flash Spectrum)



The Zeeman effect: a strong magnetic field splits the spectral lines into two or more components. The strength of the magnetic field can be measured from the amount of separation of the components. Sunspots are regions of strong magnetic fields.

De praktijk eist soms meer: spectralanalyse ontgroeit haar kernel

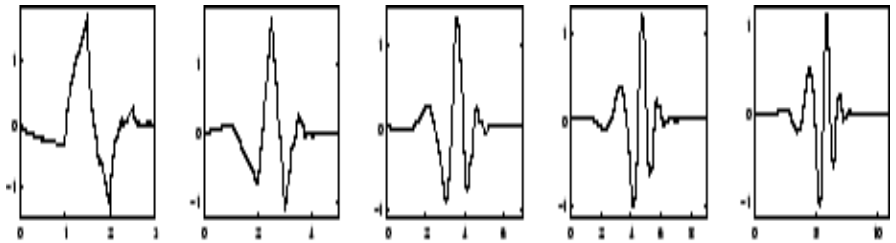
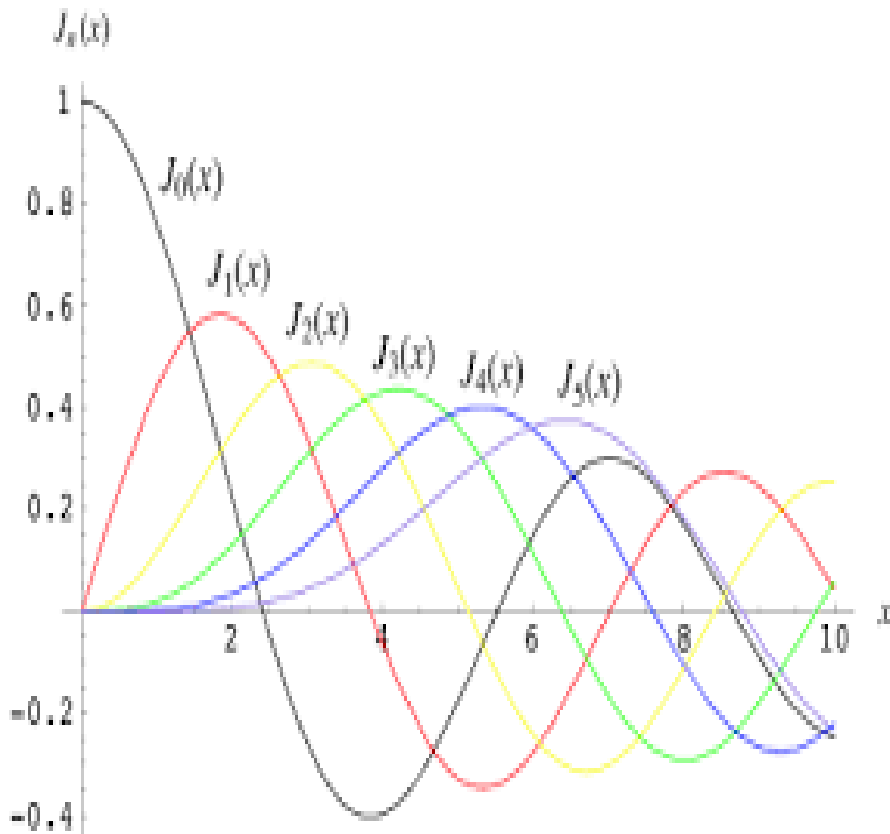
Harmuth zegt: sequency als
grondslag en daarna selectie op
maat van de vorm van het signaal
door een computer

Storingen

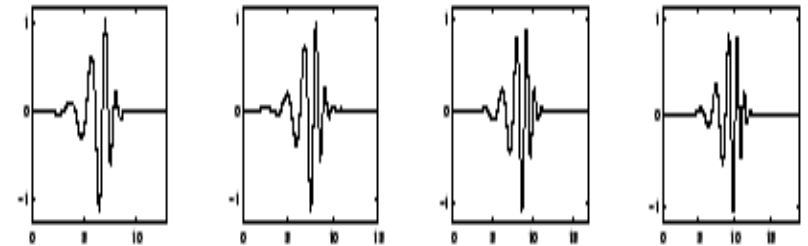
Pulsen

Asteroseismologie

De praktijk is anders dan Fourier's golven: Bessel, Deaubechies' Wavelets, Fractals, Solitons, . . .



db2 db3 db4 db5 db6



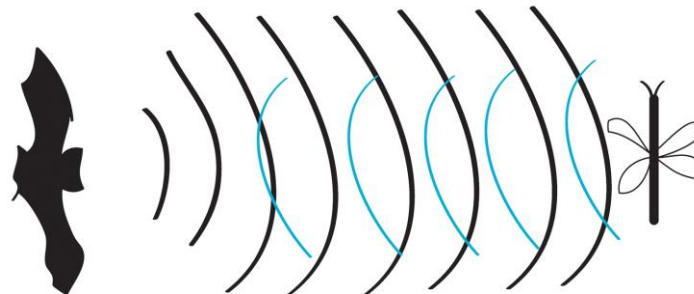
db7 db8 db9 db10

Bijv. Uitbarstingen of korte signalen

Walvissen, dolfijnen, vleermuizen gingen ons voor: korte signalen en dan luisteren naar de weerkaatsing.



Echolocation



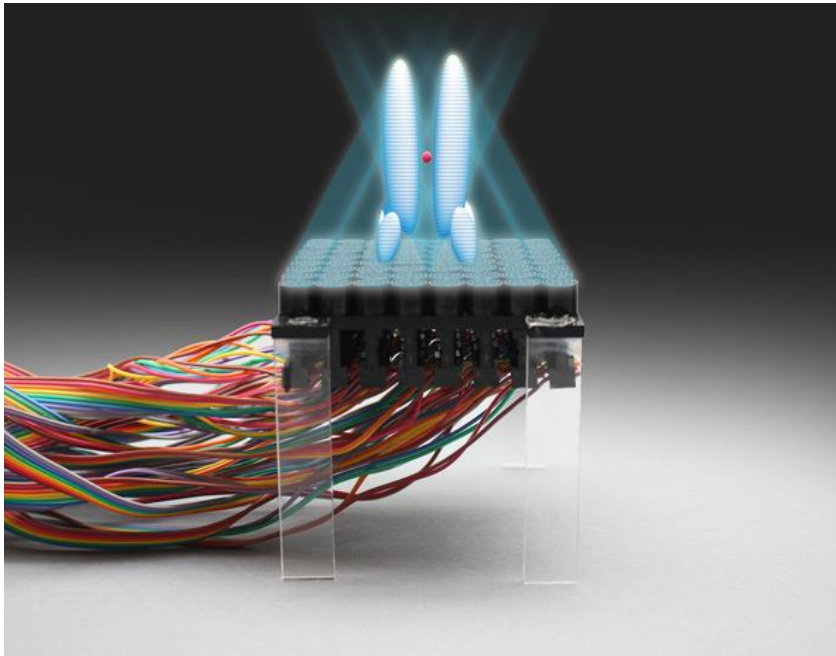
Bats emit sonar signals in order to locate potential prey. The signals bounce back if they hit an object. Bats are able to interpret the signals to see if the object is large or small and if it is moving toward or away from them.

Fononen en fotonen

Fonon = bewegingsquantum

Foton = stralingsquantum

Indianen gebruikten dat om licht te geven met rammelaars (kwarts):

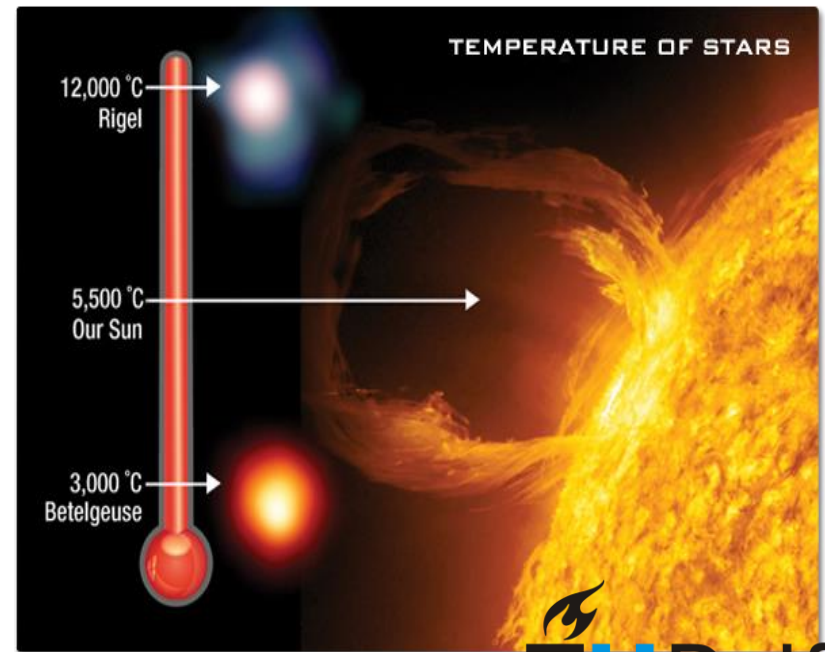
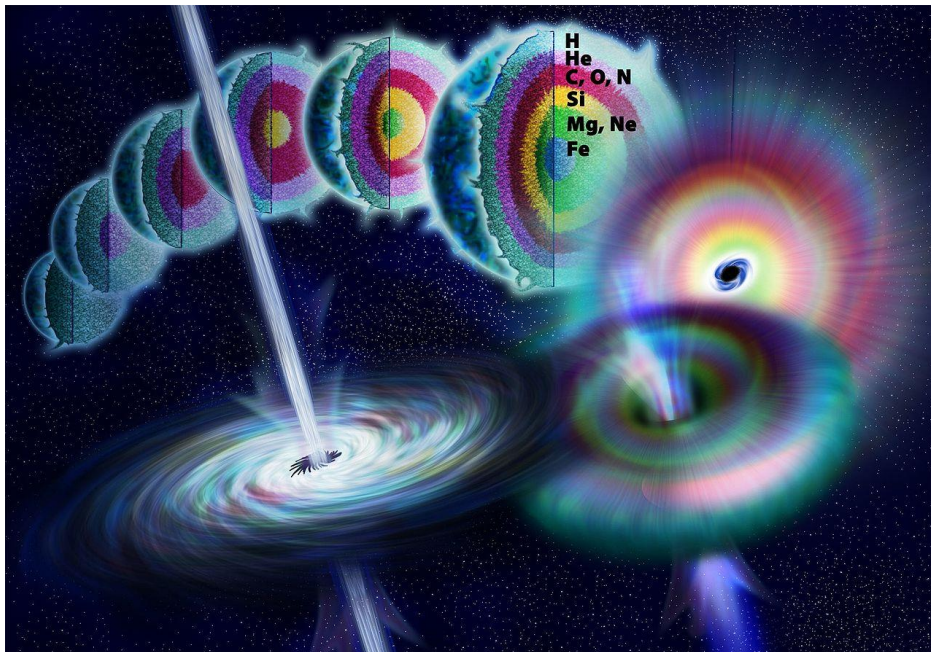


Astro-seismologie: ontdekking van het innerlijk der sterren

Als signalen indirect zijn?

Of signalen zijn te kort ?

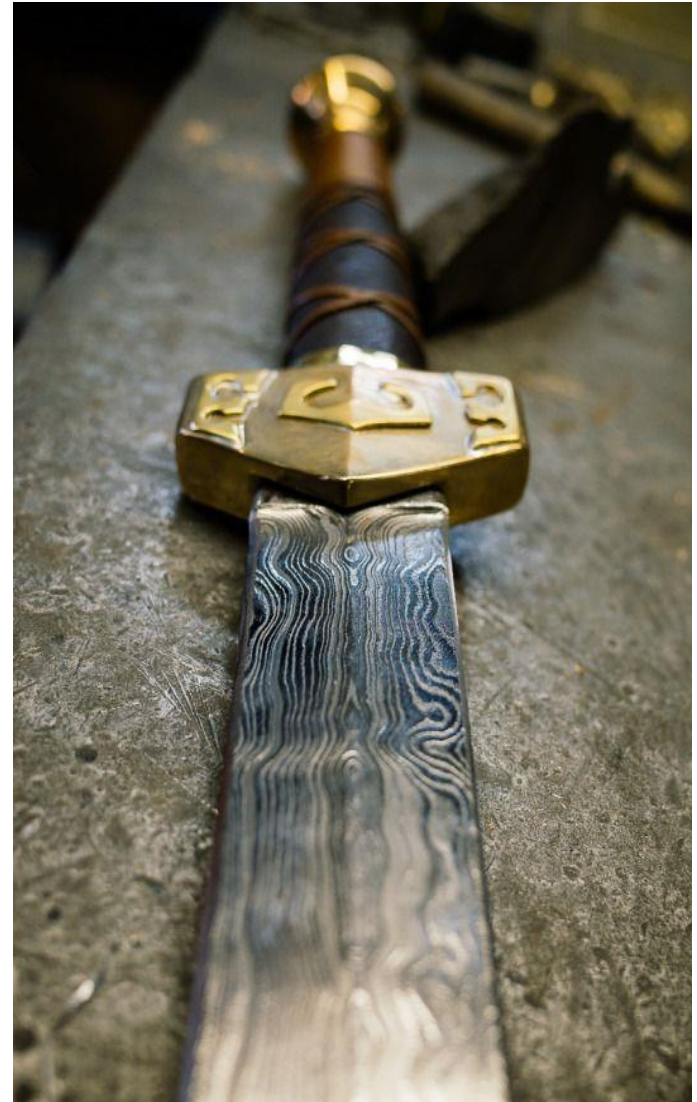
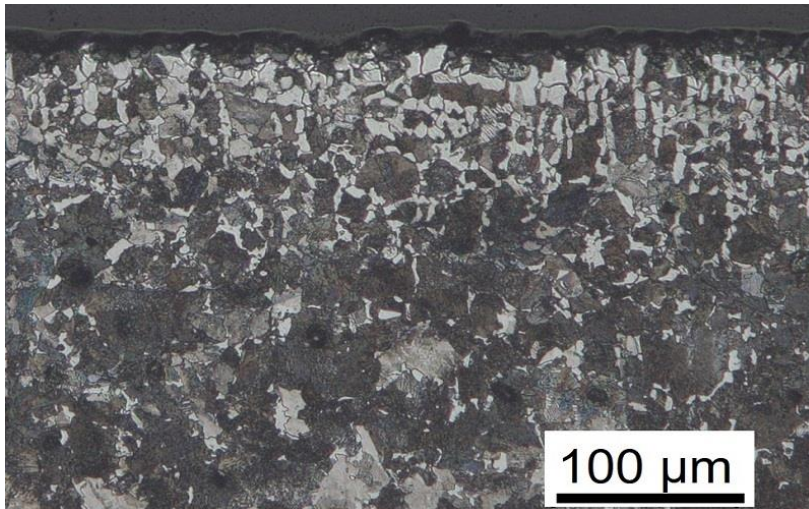
Phononen maken materie



Experimenteel toeval:

een superkorte lichtflits op een groepje
ijzeratomen deed deze zich ordenen (door heel
snel weer af te koelen).

Het superstaal van de Egyptenaren: met X-
spectraal analyse gaf meteorieten staal aan:



Spectraalanalyse van Korte signalen vereist maatwerk

Bewustwording dat golven heel anders kunnen zijn: CERN 1956 solitons: htwikiwaves







AI brengt krachtiger middelen: wat WIJ niet kennen is ruis

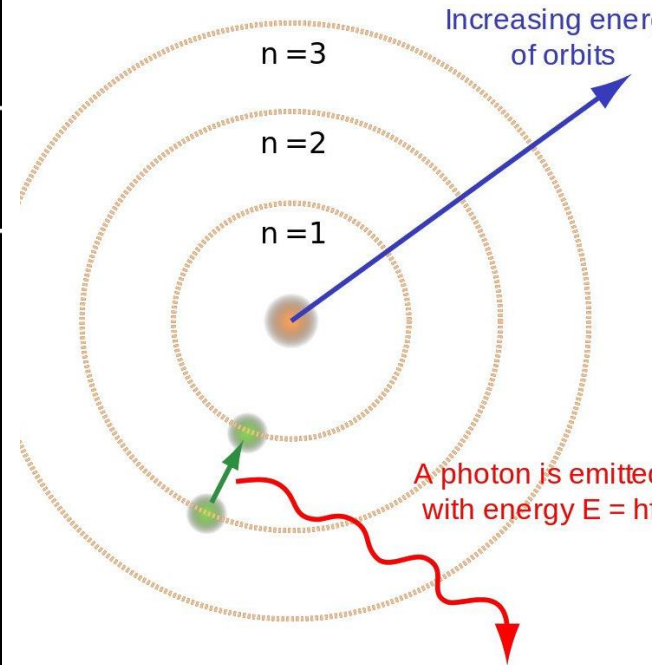
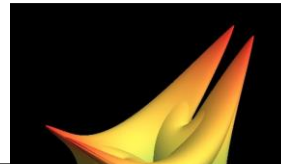
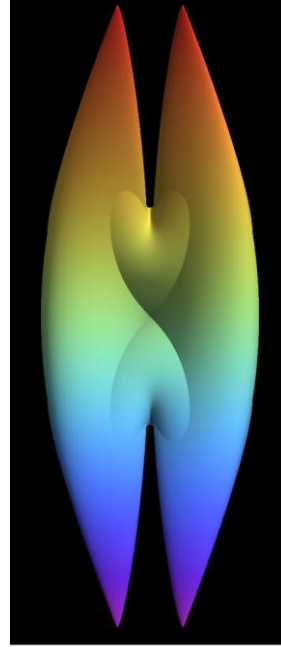
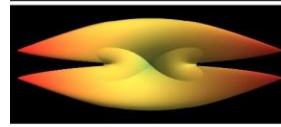
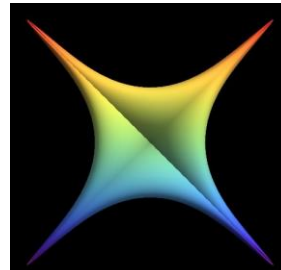
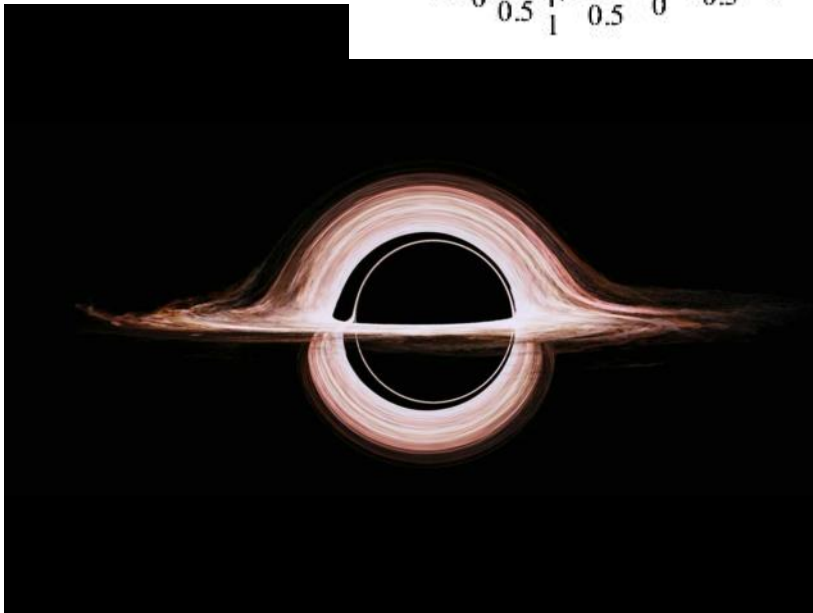
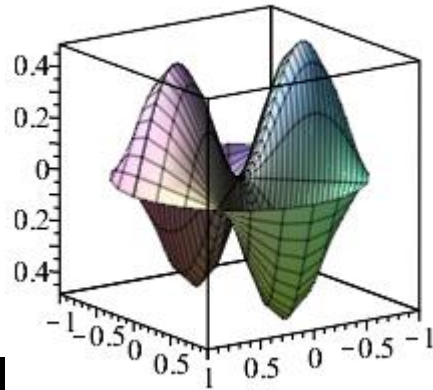
Machine learning: spectral analyse met onbekende golven: q-deformed waves



$$\begin{aligned}
 & \frac{21}{3} + \frac{65}{24} \sin\left(3t + \frac{53}{30}\right) + \frac{11}{39} \sin\left(4t + \frac{61}{25}\right) + \\
 & \sin\left(6t + \frac{15}{44}\right) + \frac{13}{24} \sin\left(7t + \frac{62}{43}\right) + \\
 & \sin\left(9t + \frac{36}{23}\right) + \frac{3}{22} \sin\left(10t + \frac{46}{29}\right) + \\
 & - \sin\left(12t + \frac{89}{40}\right) + \frac{103\,760}{29} \\
 & 10 \gg + \\
 & \left(-\frac{21}{21} \sin\left(\frac{35}{35} - 12t\right) - \frac{175}{41} \sin\left(\frac{6}{4} - 11t\right) - \frac{175}{51} \sin\left(\frac{6}{5} - 10t\right) - \right. \\
 & \quad \frac{1739}{35} \sin\left(\frac{83}{84} - 3t\right) + \frac{1993}{17} \sin\left(t + \frac{47}{26}\right) + \frac{3138}{73} \sin\left(2t + \frac{15}{23}\right) + \\
 & \quad \frac{1513}{38} \sin\left(4t + \frac{39}{17}\right) + \frac{211}{10} \sin\left(5t + \frac{95}{24}\right) + \frac{409}{30} \sin\left(6t + \frac{113}{37}\right) + \\
 & \quad \left. \frac{244}{41} \sin\left(7t + \frac{144}{31}\right) + \frac{97}{28} \sin\left(8t + \frac{86}{31}\right) + \frac{105}{16} \sin\left(9t + \frac{243}{61}\right) + \frac{1548}{7} \right) \\
 & \theta(3\pi - t) \theta(t + \pi) \theta\left(\sqrt{\operatorname{sgn}\left(\sin\left(\frac{t}{2}\right)\right)}\right), \\
 & \left(\left(-\frac{1}{23} \sin\left(\frac{7}{24} - 10t\right) + \frac{482}{21} \sin\left(t + \frac{8}{5}\right) + \frac{61}{50} \sin\left(2t + \frac{73}{31}\right) + \right. \right. \\
 & \quad \frac{45}{17} \sin\left(3t + \frac{110}{73}\right) + \frac{23}{42} \sin\left(4t + \frac{107}{48}\right) + \frac{13}{14} \sin\left(5t + \frac{30}{19}\right) + \\
 & \quad \frac{10}{33} \sin(\ll 1 \gg) + \frac{20}{59} \sin\left(7t + \frac{27}{16}\right) + \frac{3}{29} \sin\left(8t + \frac{131}{39}\right) + \\
 & \quad \left. \frac{4}{27} \sin\left(9t + \frac{17}{18}\right) + \frac{7}{36} \sin\left(11t + \frac{53}{74}\right) + \frac{3}{37} \sin\left(12t + \frac{9}{8}\right) - \frac{11\,131}{37} \right) \\
 & \theta(47\pi - t) \theta(t - 43\pi) + \ll 11 \gg \theta\left(\sqrt{\operatorname{sgn}\left(\sin\left(\frac{t}{2}\right)\right)}\right) \}
 \end{aligned}$$

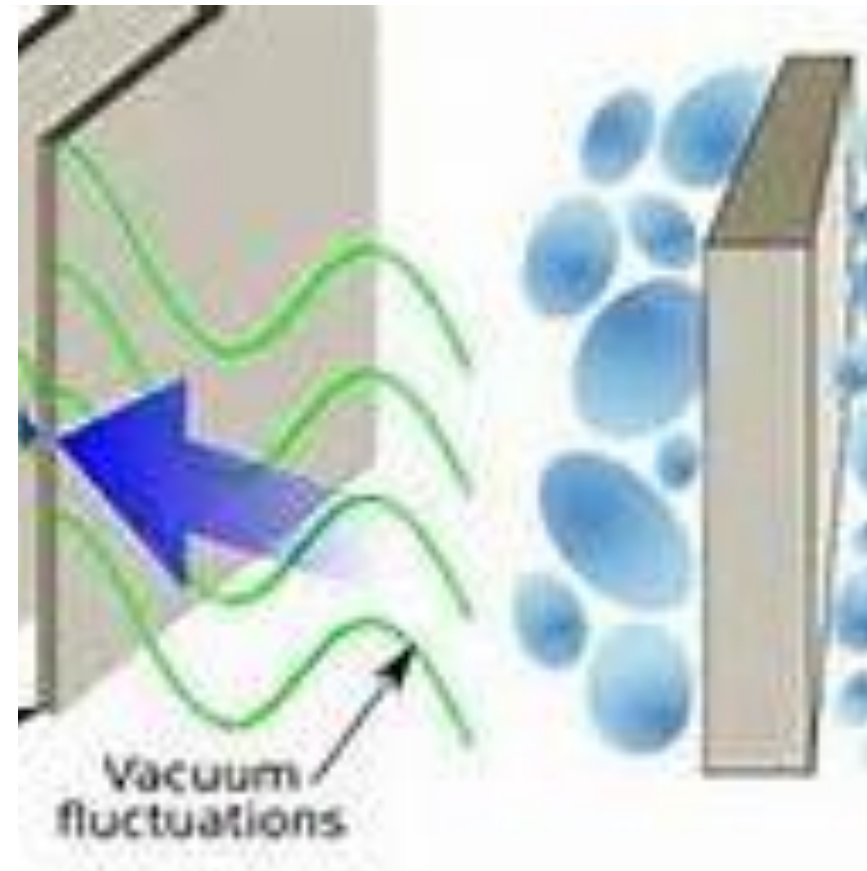
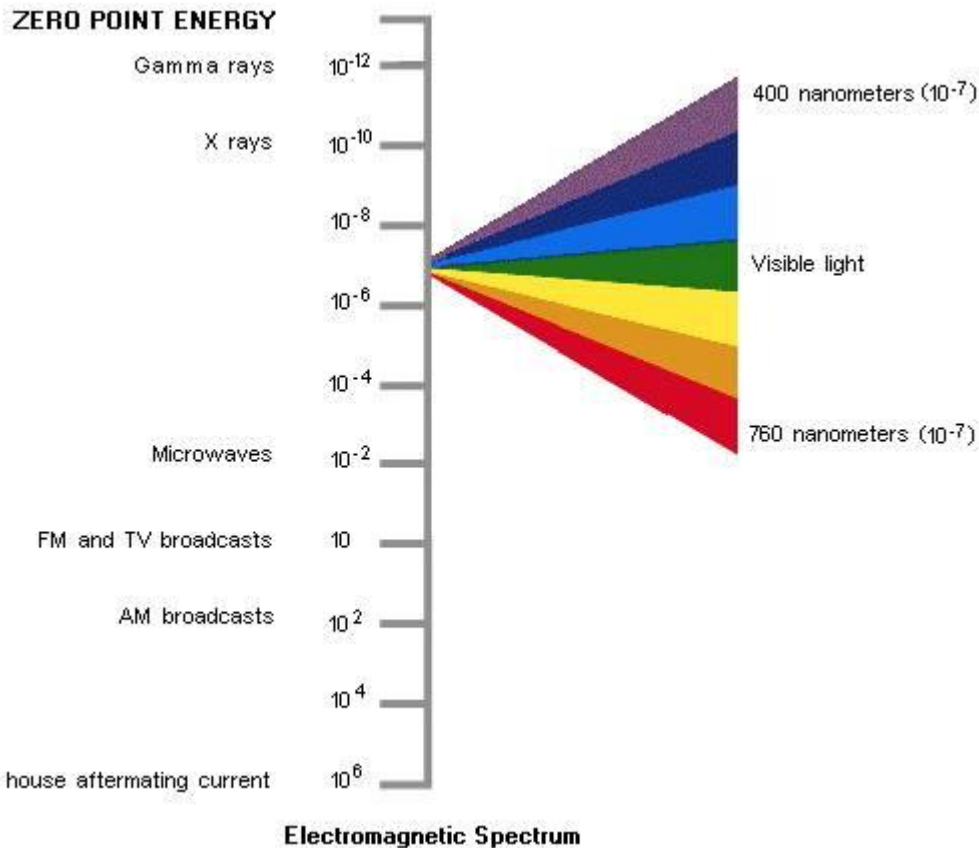
Quantum = Deeltje & Golf

Axions



De kortste
golven: de meeste
energie

Scientific American November
2019: **Terugkeer van
de Ether**





Op je mobiel een goedkope spectrometer:

Door Pereira en Hosker

Waar?

Low-cost (<€5), open-source, potential alternative to commercial spectrophotometers

PLoS Biology 17(6): e3000321.

<https://doi.org/10.1371/journal.pbio.3000321>

Published: June 12, 2019