Emergence and Evolution of Meaning

The GDI Revisiting Programme Part II: The Regressive Perspective: Bottom-Up

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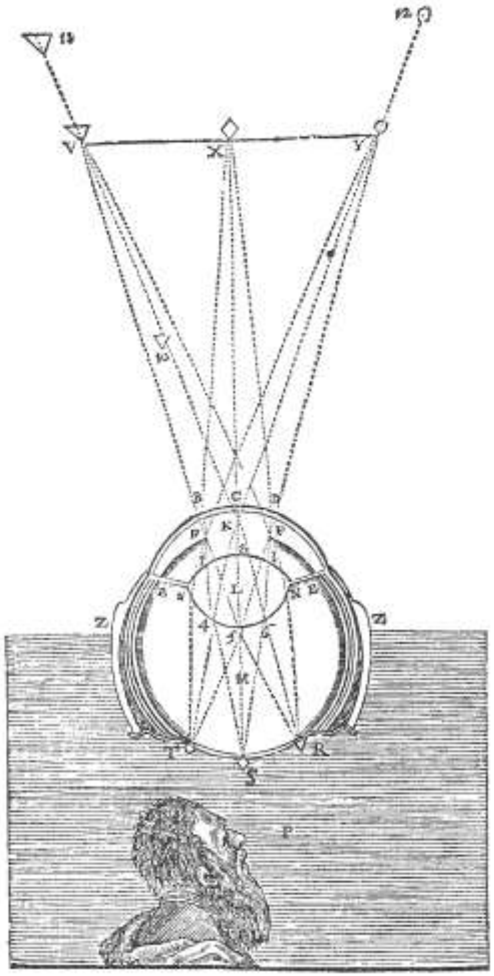
“Ὁδός ἄνω καί κάτο μία καί ώυτή”
“The way up and the way down is one and the same”
Heraklitos of Efesos
Hermeneutical circle

The regressive perspective: bottom-up

0. The case of perception
   a) limits
   b) Direct and inverse EM problems
1. Direct problem (dimensionality question)
   a) Forward formulation
   b) Sampling theorems
   c) Forward problem
2. Inverse problem (interpretation question)
   a) Forward formulation
   b) Sampling theorems
   c) The limits of observation
3. Interpreting reality
   a) Reactive
   b) Reflexive
   c) Perspectivistic

The limits of our perception

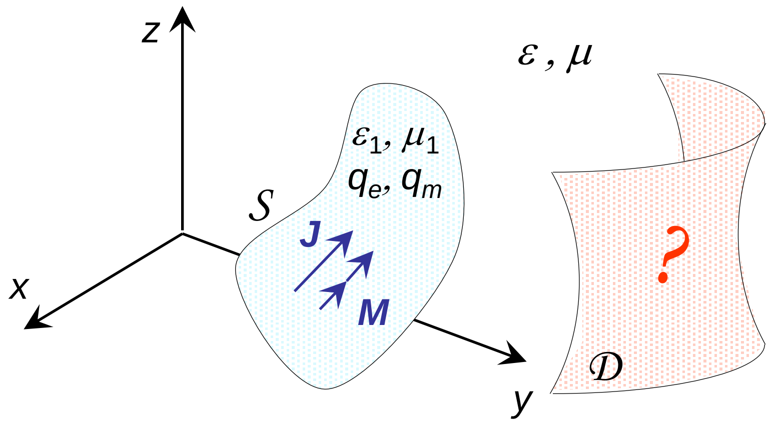


1°	We only perceive surfaces	*Huygens Theorem*
2°	Every angle around the object is necessary	*Unicity Theorem*
3°	The discernible details of a thing are not smaller than $\lambda/2$	*Sampling Theorem*
4°	In case of no sensibility to phase, spatial perception is through the observation at 2 surfaces feasible	*Phaseless Unicity Theorem*

The forward- and the inverse problems

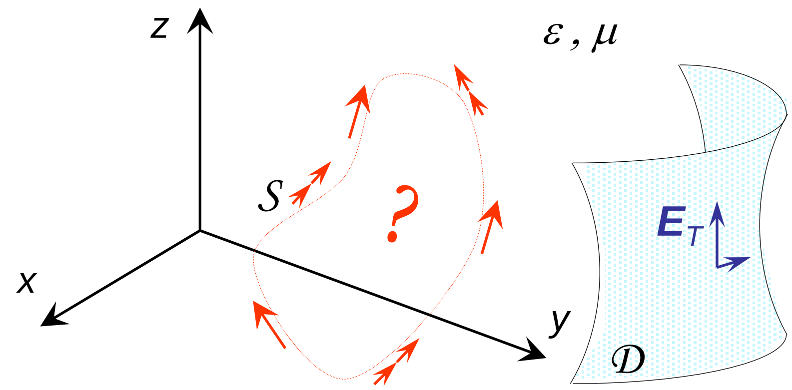
The forward Problem

Maxwell laws



The inverse Problem

Huygens-Schelkunoff Theorems



$$\{\mathbf{J},\mathbf{M}\} \xrightarrow[]{\text{linear, 2-dimesional}} \{\mathbf{E},\mathbf{H}\}$$

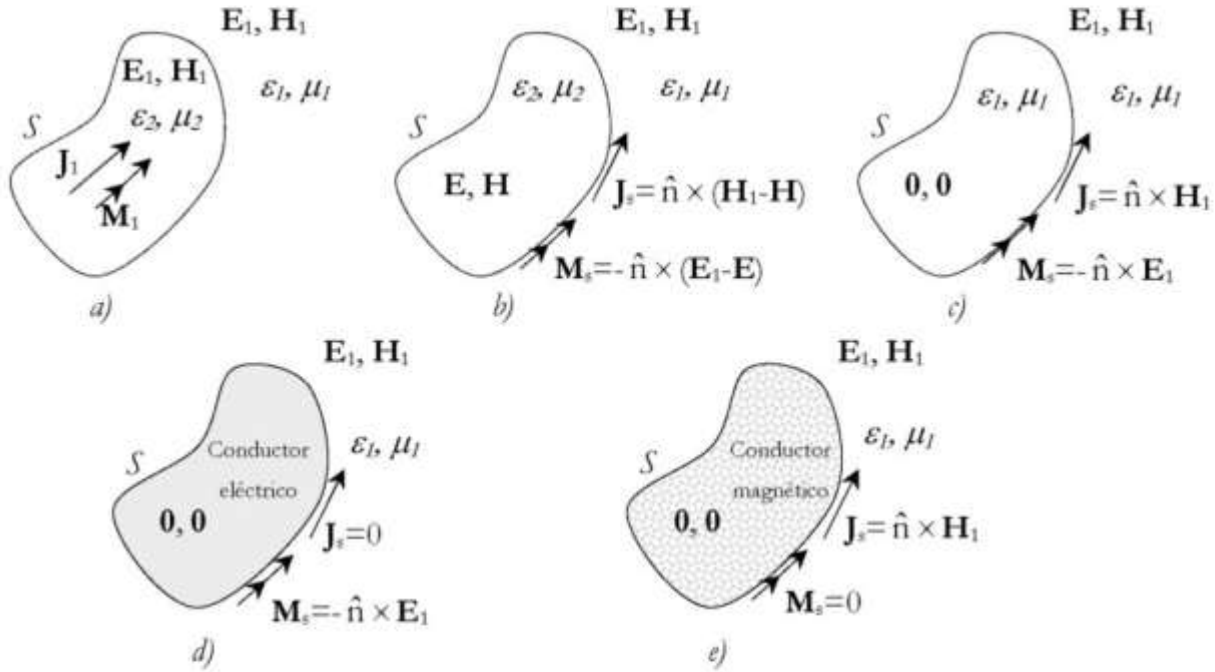
?

Unicity and Equivalence theorems

Unicity theorem

$[\boldsymbol{E}_1, \boldsymbol{H}_1]$
$[\boldsymbol{E}_2, \boldsymbol{H}_2]$ } $[\delta \boldsymbol{E}, \delta \boldsymbol{H}]$ no energy crosses through $\mathcal{D}$

Equivalence Theorem



Forward formulation

Vector potentials ***A*** and ***F*** (*D'Alambert*-Eq.):

$$\nabla^2\mathbf{A}+\beta^2\mathbf{A}=\begin{cases}-\mu\mathbf{J}(\mathbf{r}') & \text{inside } S\\ 0 & \text{outside } S\end{cases}$$

$$\nabla^2\mathbf{F}+\beta^2\mathbf{F}=\begin{cases}-\varepsilon\mathbf{M}(\mathbf{r}') & \text{inside } S\\ 0 & \text{outside } S\end{cases}$$

$$(\nabla^2+\beta^2)G(\boldsymbol{r},\boldsymbol{r}')=-\delta(\boldsymbol{r}-\boldsymbol{r}')$$

$$G(\boldsymbol{r},\boldsymbol{r}')=\frac{e^{-j\beta\mathrm{R}(\boldsymbol{r}-\boldsymbol{r}')}}{4\pi\mathrm{R}(\boldsymbol{r}-\boldsymbol{r}')}$$

Convolutional solution:

$$\boldsymbol{A}(\boldsymbol{r})=\mu\iiint_{V'}\boldsymbol{J}(\boldsymbol{r}')\cdot G(\boldsymbol{r}-\boldsymbol{r}')dv'=\mu\boldsymbol{J}(\boldsymbol{r})*G(\boldsymbol{r})$$

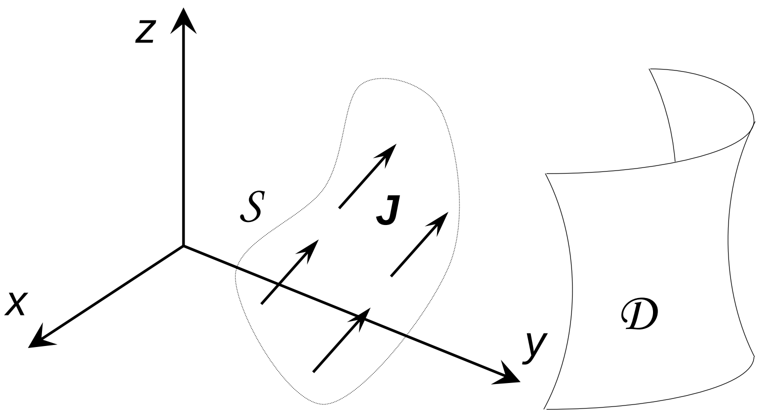
$$\boldsymbol{F}(\boldsymbol{r})=\varepsilon\iiint_{V'}\boldsymbol{M}(\boldsymbol{r}')\cdot G(\boldsymbol{r}-\boldsymbol{r}')dv'=\varepsilon\boldsymbol{M}(\boldsymbol{r})*G(\boldsymbol{r})$$

$$\xrightarrow{\mathrm{F}}\begin{cases}\widetilde{\boldsymbol{A}}(\boldsymbol{r})=\mu\widetilde{\boldsymbol{J}}(\boldsymbol{r})\cdot\widetilde{G}(\boldsymbol{r})\\ \widetilde{\boldsymbol{F}}(\boldsymbol{r})=\varepsilon\widetilde{\boldsymbol{M}}(\boldsymbol{r})\cdot\widetilde{G}(\boldsymbol{r})\end{cases}$$

Fields ***E***, ***H***:

$$\begin{cases}\boldsymbol{E}=-j\omega\left\{1+\frac{\nabla\nabla}{\beta^2}\right\}\boldsymbol{A}-\frac{1}{\varepsilon}\nabla\times\boldsymbol{F}\\ \boldsymbol{H}=-j\omega\left\{1+\frac{\nabla\nabla}{\beta^2}\right\}\boldsymbol{F}+\frac{1}{\mu}\nabla\times\boldsymbol{A}\end{cases}$$

Forward Formulation
(real sources)



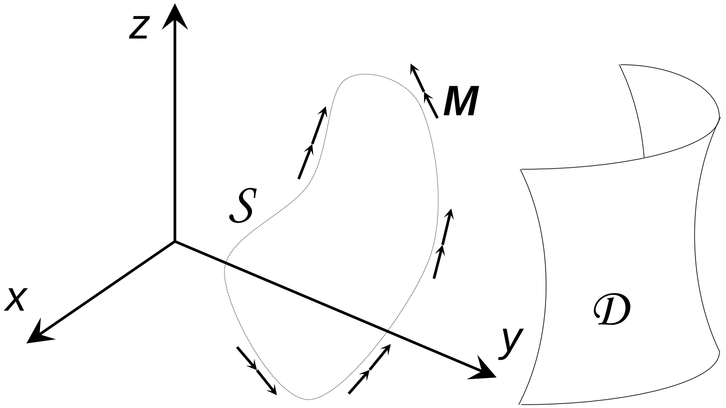
Only electrical currents: ***F***=0

$$\boldsymbol{E}_{\boldsymbol{J}} = \underline{\underline{\boldsymbol{G}}}_J(\boldsymbol{r}) * \boldsymbol{J}(\boldsymbol{r}) \xrightarrow{\text{F}} \widetilde{\boldsymbol{E}}_{\boldsymbol{J}} = \underline{\underline{\widetilde{\boldsymbol{G}}}}_J(\boldsymbol{r}) \cdot \widetilde{\boldsymbol{J}}(\boldsymbol{r})$$

$$\begin{bmatrix} E_{J_x} \\ E_{J_y} \\ E_{J_z} \end{bmatrix} = \iiint_{V'} \begin{bmatrix} G_1(\mathrm{R})+G_2(\mathrm{R})(x-x')^2 & G_2(\mathrm{R})(x-x')(y-y') & G_2(\mathrm{R})(x-x')(z-z') \\ G_2(\mathrm{R})(y-y')(x-x') & G_1(\mathrm{R})+G_2(\mathrm{R})(y-y')^2 & G_2(\mathrm{R})(y-y')(z-z') \\ G_2(\mathrm{R})(z-z')(x-x') & G_2(\mathrm{R})(z-z')(y-y') & G_1(\mathrm{R})+G_2(\mathrm{R})(z-z')^2 \end{bmatrix} \cdot \begin{bmatrix} J_x(\boldsymbol{r}') \\ J_y(\boldsymbol{r}') \\ J_z(\boldsymbol{r}') \end{bmatrix} \cdot dv'$$

$$G_1(\boldsymbol{r}-\boldsymbol{r}') = -\frac{j\omega\mu}{4\pi\beta^2}\frac{-1-j\beta\mathrm{R}+\beta^2\mathrm{R}^2}{\mathrm{R}^3}e^{-j\beta\mathrm{R}} \qquad G_2(\boldsymbol{r}-\boldsymbol{r}') = -\frac{j\omega\mu}{4\pi\beta^2}\frac{3+j3\beta\mathrm{R}-\beta^2\mathrm{R}^2}{\mathrm{R}^5}e^{-j\beta\mathrm{R}}$$

Forward Formulation (equivalent magnetic sources)



Only magnetic currents: ***A***=0

$$\boldsymbol{E}_M = \underline{\underline{\boldsymbol{G}_M}}(\boldsymbol{r}) * \boldsymbol{M}(\boldsymbol{r}) \xrightarrow{\mathbf{F}} \tilde{\boldsymbol{E}}_M = \underline{\underline{\tilde{\boldsymbol{G}}_M}}(\boldsymbol{r}) \cdot \tilde{\boldsymbol{M}}(\boldsymbol{r})$$

$$\begin{bmatrix} E_{Mx} \\ E_{My} \\ E_{Mz} \end{bmatrix} = \iint_{S'} G_3(\mathrm{R}) \cdot (\boldsymbol{r} - \boldsymbol{r}') \times \boldsymbol{M}(\boldsymbol{r}') ds' = \iint_{S'} \left(G_3(\mathrm{R}) \cdot \begin{bmatrix} 0 & (z - z') & -(y - y') \\ -(z - z') & 0 & (x - x') \\ (y - y') & -(x - x') & 0 \end{bmatrix} \right) \cdot \begin{bmatrix} M_x(\boldsymbol{r}') \\ M_y(\boldsymbol{r}') \\ M_z(\boldsymbol{r}') \end{bmatrix} \cdot ds'$$

$$G_3(\boldsymbol{r} - \boldsymbol{r}') = \frac{1}{4\pi} \frac{1 + j\beta \mathrm{R}}{\mathrm{R}^3} e^{-j\beta \mathrm{R}}$$

Sampling theorems for radiating fields

Theorem 1: *The minimal distance between independent intensity values of a field generated by an arbitrary object is $\lambda/2$.*

Theorem 2: *The maximum number of details of an object, inscribed in an sphere of radius a, which is causing an observed field distribution is 16 $\pi(a\chi/\lambda)^2$. This is the* ***essential dimension*** *of the observation problem*.

Theorem 3: *The minimal distance between independent values of the field corresponding to the manifestation of an object inscribed in a sphere of radius a, whose centre is at a distance d, is: $\lambda d/2a\chi$.*

Forward (discretized) problem

- Phenomena observed at $\mathcal{D}$ (u,v) corresponding to a set of sources

Green equation
$x', y', z' \rightarrow u, v$
Source (object) — Observation domain

$$\begin{pmatrix}\Psi(u_1,v_1)\\ \vdots \\ \Psi(u_M,v_M)\end{pmatrix} = \begin{pmatrix} G(u_1,v_1,x'_1,y'_1,z'_1) & \cdots & G(u_1,v_1,x'_N,y'_N,z'_N) \\ \vdots & \ddots & \vdots \\ G(u_M,v_M,x'_1,y'_1,z'_1) & \cdots & G(u_M,v_M,x'_N,y'_N,z'_N)\end{pmatrix} \times \begin{pmatrix} f(x'_1,y'_1,z'_1)\\ \vdots \\ f(x'_N,y'_N,z'_N)\end{pmatrix}$$

Phenomena — Source

Wave function

$$\mathbf{\Psi} = \begin{pmatrix}\Psi_1\\ \vdots \\ \Psi_M\end{pmatrix} = \sum_{n=1}^{N}\begin{pmatrix}\psi_1\\ \vdots \\ \psi_M\end{pmatrix}\cdot f_n = \sum_{n=1}^{N}\mathbf{\Psi}_n\cdot f_n = \mathcal{T}\cdot \boldsymbol{f}$$

where $\mathbf{\Psi}_n = \begin{pmatrix} G(u_1,v_1,x'_n,y'_n,z'_n)\\ \vdots \\ G(u_M,v_M,x'_n,y'_n,z'_n)\end{pmatrix}$

Direct problem (manifestation of reality) $\mathbf{\Psi} = \sum_{n=1}^{N}\mathbf{\Psi}_n\cdot f_n = \mathcal{T}\cdot \boldsymbol{f}$

Inverse problem

- A good way to suit our problem (to be invertible) is locating *N* punctual sources over s regularly spaced at a distance $\lambda/2$x

$$\mathbf{\Psi} = \begin{Bmatrix} \mathbf{\Psi}_{OBSERVED} \\ \mathcal{T} \cdot f_{\text{projection}} \end{Bmatrix} \Rightarrow$$

$$\exists f_{\text{projection}} = [\mathcal{T}^{+} \cdot \mathcal{T}]^{-1} \mathcal{T}^{+} \cdot \mathbf{\Psi}_{OBS.} \Big/ \min_{f} \left\{ d\left(\mathcal{T} \cdot f_{\text{projection}}, \mathbf{\Psi}_{OBS.} \right) \right\}$$

- Which can have a unique solution.

The limits of observation

1. A **Finite Number of Details** related to the object can be found.
2. Such number **depends on the surface bounding** the object.
3. The **volumetric distribution** of an object **cannot be known** only based on its manifestations on the environment.
4. The description of the object that can be achieved corresponds to a **projection of the inner inhomogeneities** over S.

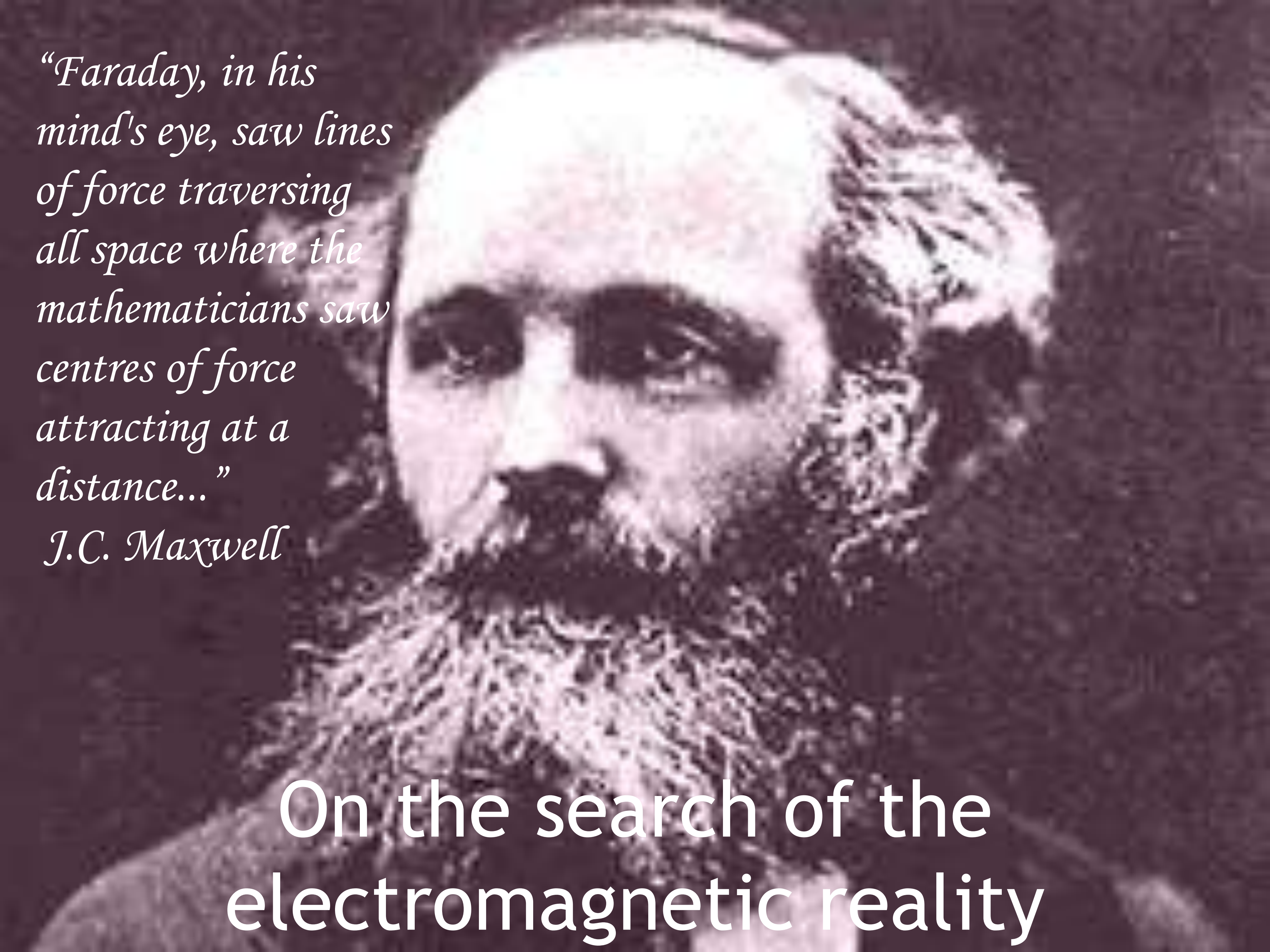
- **Fundamental limits** to the observation problem, not related to sense structure, but to the **differences that can be found**
- Related to the **maximal *a posteriori* knowledge**
- $\underbrace{\text{Complexity}_{\text{Object}} \text{ can be}}_{\textit{Unknown}} > \underbrace{\text{Complexity}_{\text{its Manifestation}}}_{\textit{Given}}$

The meaning-offer of observation vs perception

Reality	$\mathbf{s}(\mathbf{r}) = \sum_{i=1}^{N_O} s_i \delta(\mathbf{r} - \mathbf{r}')$	
Message (manifestation)	$\mathbf{\Psi}(\mathbf{r}) = \mathbf{s} * G(r) = \sum_{i=1}^{N_O} s_i G(\mathbf{r} - \mathbf{r}'_i)$	$\hat{\mathbf{\Psi}}(\mathbf{r}) = \hat{\mathbf{s}} * G(r) = \sum_{i=1}^{N} \hat{s}_i G(\mathbf{r} - \hat{\mathbf{r}}'_i)$
Meaning-offer		$\hat{\mathbf{s}}(\{\hat{\mathbf{r}}'\}) = \sum_{i=1}^{N} \hat{s}_i \delta(\mathbf{r} - \hat{\mathbf{r}}') = \mathbf{\Psi}(\mathbf{r}) * G^{-1}(\mathbf{r})$

Reality and Manifestation of the emitter (object)

What is offered to the receptor (subject) concerning the object



“Faraday, in his mind's eye, saw lines of force traversing all space where the mathematicians saw centres of force attracting at a distance...”

J.C. Maxwell

On the search of the electromagnetic reality

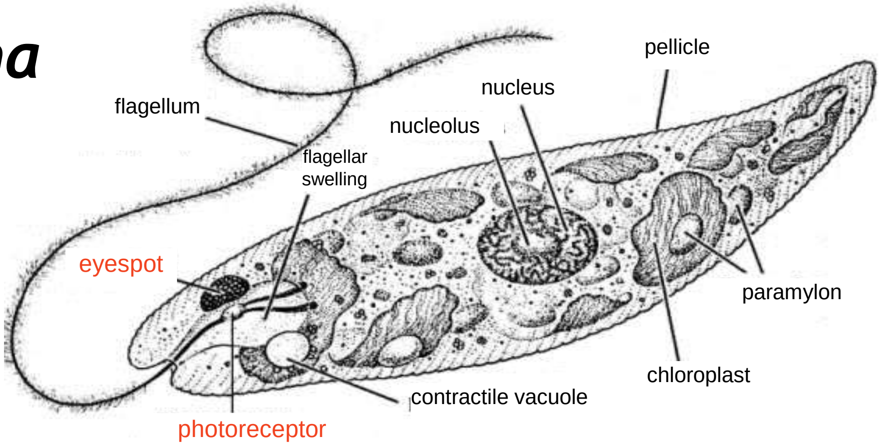
Interpreting reality (reactiv)

- The more **complex** the sensitive structure, the greater the **ambiguity** of its perception and the more **accurate** the determination of the object.
- The **cell** has several means to sense the environment and to adapt to those variations which are relevant for its survival

- Protovision of the ***Euglena viridis***:

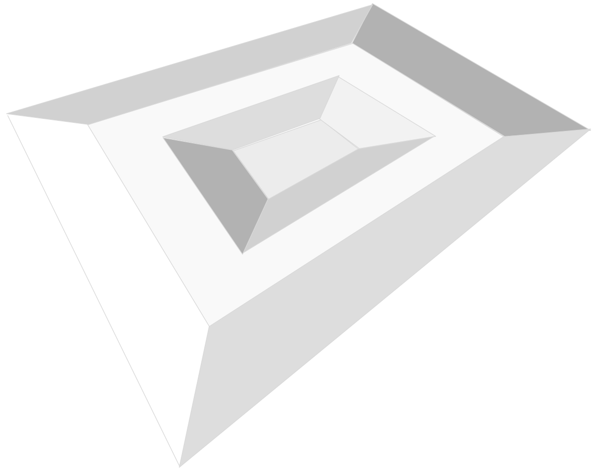
  brightness (high/low), direction
- Animal vision:

  accuracy↑ and ambiguity↑

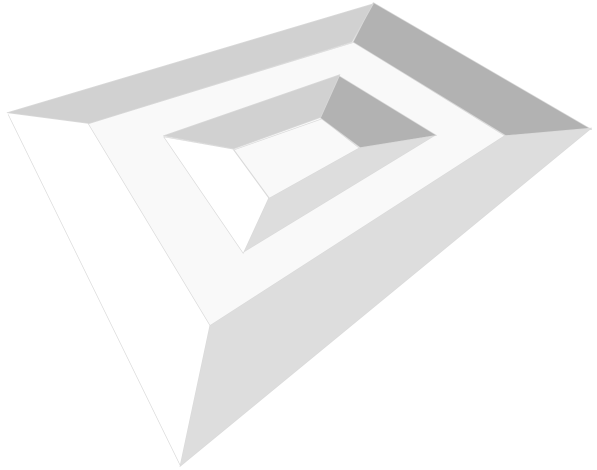


Interpreting reality (reflexive)

a) regular hole or irregular coloured protuberance



b) irregular protuberance or regular coloured hole



- The preferred perceptions tend to be those corresponding to the simplest configurations (Ockam’s razor)

onto-epistemic information

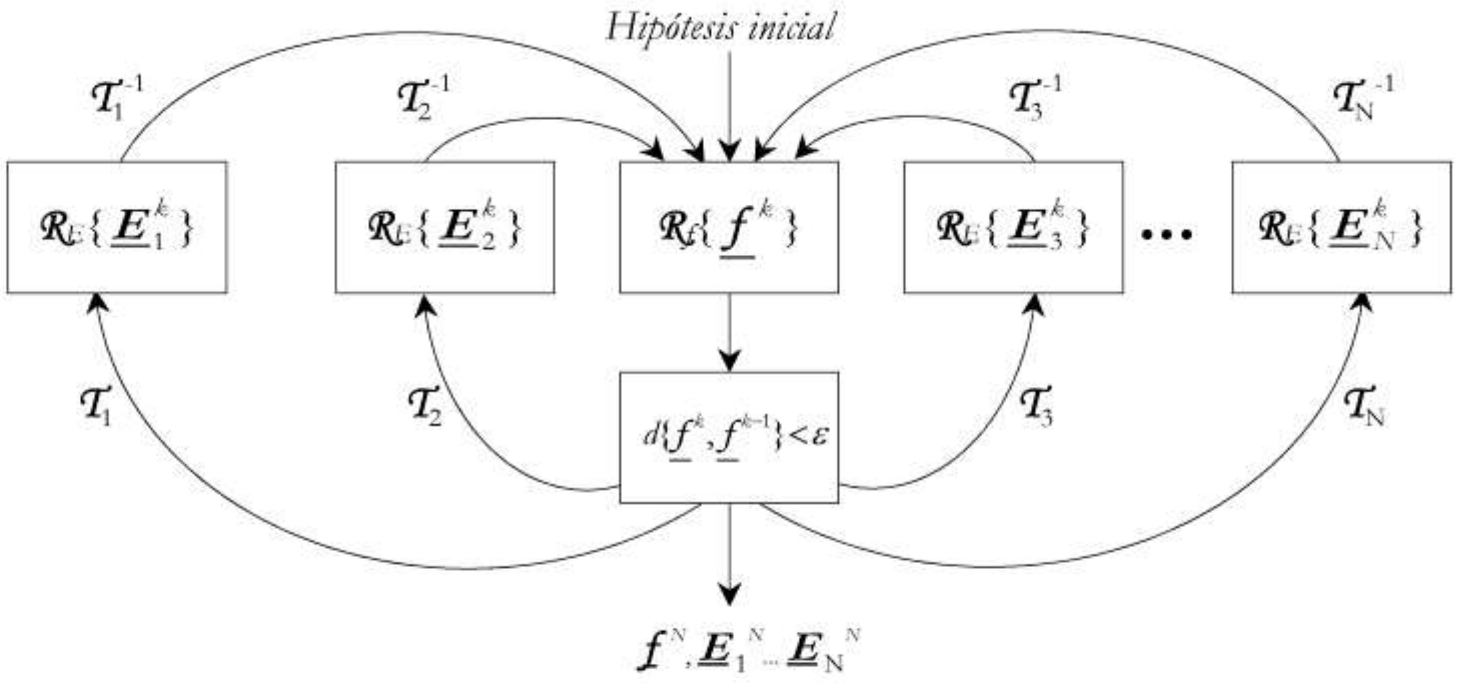
Reality itself + Complex Structure of perception and intellection

unitary act: *sensing reality*

$\supset$ *transcendence* (openness)

Perspectivistic approach to reality

Generalized method of successive projections



Perspectivistic approach to reality

- Is False Information no information?
  - Contradictions(within epistemological level), p = 0,
    - (Floridi-GDI) I = 0? *Epistemological closure*
    - We need new models - *Epistemological openess*
  - Opositions (between significance and reference), p >0
    - (Floridi-GDI) I < 0? *Pragmatical closure*
    - There is no communication cooperation

Thank you for your attention

Emergency and evolution of meaning

Cordially thankful to the organisers

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