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Messages in an Open Universe

A subtle chain of countless rings
The next unto the farthest brings;
The eye reads omens where it goes,
And speaks all languages the rose;
And, striving to be man, the worm
Mounts through all the spires of form.
Emerson, R.W. (1836)

In 1947, Kotelnikov found out – in his mathematical inquiry to improve reception – the optimal way to get rid of noise given a known set of possible messages. The current architecture of optimal receptors follows the path depicted by Kotelnikov, which does not deviate from the course pointed out by Plato in his theory of ideas and the later idealist tradition. Kotelnikov's solution shows that it is the form of the expected messages that has to be used by the recipients to clean the received messages from the unwanted noise, and this is roughly the criterion held by the idealist tradition to support the possibility of real knowing after all, given our brief and limited contact with the world. It stands for the ability of Meno's uneducated boy to reckon the Pythagorean Theorem (Plato, *Meno*, 82-84), or Augustine's possibility to get rid of "the contradictory throng of phantasms", thus finding the wanted "unchangeable" among the "changeable" (Augustine, *Conf.*, 7.23). And it is Emerson's ground for understanding the "languages of the rose" or "the order of things." (Emerson 1836, 1)

As pointed out by Chomsky, if Plato's problem deals with the marvel of knowing so much given our limitations, we also have to confront – in our contemporary societies – the counter-problem of knowing "so little given that we have so much evidence" (Chomsky 1986, p. xxv). Chomsky names the latter: "Orwell's problem", which in practical contexts of deciding what to do – given a real and so poorly understood context – has obvious dramatic consequences for the autonomy of the ignorant. In Orwell's Oceania, however, such "ignorance is strength" of the system. Moreover, this strength is in the long-term supported by the stylized language, named "Newspeak", whose characteristics are not so far from Kotelnikov's solution for optimal reception (Orwell 1949). Thus, though both extreme problems seem to deal with an opposite end, the technical solution might be somehow connected. A net distinction can be stressed if the related universe of messages is considered closed or opened.

Might even this distinction between openness and closeness provide us a key to distinguish between "dis-angelical" and "angelical" worlds? If this openness is critical to such distinction, are the communication means of our contemporary societies providing the conditions to let us move towards a “message society” or a “time of empty angels”? (Capurro 2003).

1. Universe of Messages for an Optimal Reception

1.1 Technical model (syntactic level)

Either Shannon’s Mathematical Theory of Communication (MTC) or Kotelnikov’s Theory of Optimal Reception considers that communication is fitted to the well-known model depicted in Fig. 1 (Shannon 1948).[37] These theoretical endeavors seek the conditions to make the channels reliable given constrained resources, and they provide valuable guidelines to design them so as to optimize cleaning out the noise from the received messages. According to their theoretical principles, the error in the determination of the original message can be arbitrarily reduced – though a certain small probability of occurrence always persists. Hence, in practical cases, the goal of delivering cleaned messages in the output of the well-designed channels is achievable, so that no shadow of noise remains. In other words, original messages are coincident with decoded ones, and one can speak about “transparent channels”.

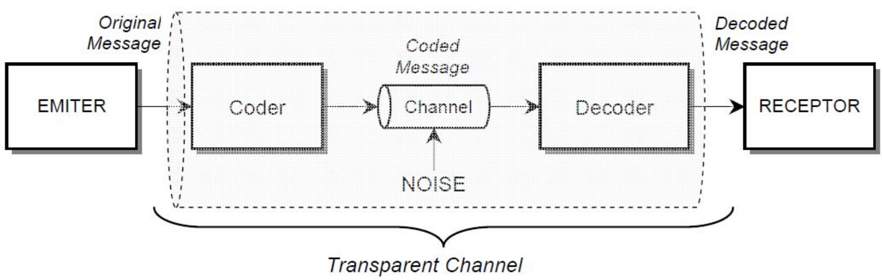

Figure 1: Communication Model generally accepted in technical approaches. If the formal conditions addressed by Kotelnikov and Shannon are met, the decoded messages shall be as close to the original ones as desired. In the practical case, we can take them as coincident without any shadow of noise; thus one can speak of “transparent channels”.

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[37] Although many aspects of Shannon’s vision on Communication has been criticized in the scientific literature (concerning for instance natural and semiotic grounds), there is a common acceptance of his communication model whose errors and limits have been discussed by the author elsewhere (Díaz and Hadithi 2009, Díaz 2010). Concerning the status of MTC, it has been occasionally highlighted that it is rather a theory of messages than a theory of information –as usually considered (Capurro and Díaz 2010).

However we may ask, what actually entails this optimal design of channels? Drawing attention to some of the properties of an optimized channel will enable us to unveil some of the related constrains to the communication being mediated by this alleged transparency.

As Kotelnikov (1947) showed, on the one hand, it is the correlation with the form of the expected signal at the receptor that allows an optimal distinction of the received signal composed by such form from the unavoidable added noise; on the other hand, when several signals are to be distinguished, the probability of error diminishes if the difference among them is maximized. How to maximize these distinctions depends on the available resources (chiefly energy and frequency), but in any case, the following relevant requirements must be satisfied:

(i) On the emitter side, the code must be properly chosen providing maximal distinctions, i.e. a set of signals whose forms must be maximally different. Such selection depends on the availability of forms (evaluable in terms of bandwidth) and energy. For given technical and practical constraints, a limited set of signals and rules for their concatenation allow an approximation to Shannon's channel capacity which states a fundamental limit to the information transmission rate (Shannon 1949).

(ii) On the receptor side, the code (determined by the set of signals and rules) has to be known and constantly contrasted in order to cancel noise and recognize the original messages with a negligible error rate.

Therefore, the agreement on the code as well as the synchronization of coder and decoder (imposed by the timing that the concatenation of signals settles) are essential aspects of the given model which are simply presupposed in these theories, but not abided by them. Hence, the communicational process attained in this model can be stated in two phases:

1) In order to communicate X, the emitter sends message Z according to code C
2) After receiving Z' (Z perturbed by noise) and according to code C, the receptor decides that the emitter intended to communicate X.

Although as argued elsewhere (Díaz and Hadithi 2009, Díaz and Capurro 2010) this model embodies – to some extent – the ideal of clarity inherent in the visions of Augustine – concerning revelation – or Locke – concerning communication –, it is also true that while these latter visions move in the territory of semantics and pragmatics, the former ones are explicitly restricted to the syntactic level (Shannon 1948, Shannon and Weaver 1949). However, this taking the separability of the syntactic, semantic and pragmatic levels for granted is far from being generally acceptable. The essentiality of semantics and pragmatics in communication is beyond question. Whereas Weaver considers that the same model of communication (Fig. 1) can simply be expanded – reproducing its schema in nested levels –, research into culture, language and semiotics shows that the reality of communication has further requirements (Eco 1973).

1.2 Complete model: first step into Orwell's problem

But not jumping beyond the given model, even Weaver considered "that the separation into the three levels is really artificial and undesirable", and correspondingly the communication code as a whole "must be designed (or developed) with a view to the totality of things that man may wish to say" (Weaver 1949). To include semantic and pragmatic aspects, we can modify the steps of the communication process given above including a reference to *communication contents* and its related situation which can be of either a semantic or pragmatic nature:

1') Referring to a communicational content X, the emitter sends message Z according to a code C in a given situation S
2') Receiving Z' (Z perturbed by noise) according to code C in a given situation S, the receptor decides that the emitter has referred to X

This view of the totality of the desired communication – claimed by Weaver – is exemplified in the Orwell's dystopian language – named "Newspeak" – as depicted in his famous novel, *Nineteen eighty-four*. In the Newspeak conceived by Orwell, the set of possible messages is optimally adapted to pragmatic goals in which the semantic level is nested:

> "Relative to our own, the Newspeak vocabulary was tiny, and new ways of reducing it were constantly being devised. Newspeak, indeed, differed from most all other languages in that its vocabulary grew smaller instead of larger every year. Each reduction was a gain, since the smaller the area of choice, the smaller the temptation to take thought." (Orwell 1989, *appx*)

According to the aforementioned principles of optimal reception, the smaller the possibility of choice and the higher the difference among messages, the lesser possibility of error. To this end, the properties of Newspeak provide a good terrain to achieve a high communicational success: on the one hand, a complete superseding of the old language is envisaged, and a flawless adoption of Newspeak (i.e. a perfect code sharing) which is structured in three vocabularies adapted to the needs of "the business of everyday life", "political purposes" and "scientific and technical" uses, respectively. On the other hand, Newspeak is made up of words that are "simply a staccato sound expressing ONE clearly understood concept" (*ibid*). Hence, it provides not only good reliability at the syntactical level, but also at the semantic and pragmatic ones. Unlike Shannon's intention to deal only with syntactic questions, Orwell's dystopian language provides a good join with other relevant levels of the communication problem. Moral and juridical questions are simply superseded:

"There would be many crimes and errors which it would be beyond his power to commit, simply because they were nameless and therefore unimaginable." (*ibid.*)

A similar solution to prevent crime on the terrain of social communication was envisaged by the French criminologist and early theoretician of public opinion, Gabriel Tarde (1901):

> "All the improvements of social organization… have the consequence of enabling that one meditated, coherent, individual project arrives purer, less polluted, deeper, and through the safest and shortest means in the minds of all partners" (Tarde 1986, 149)

Contrasted with Orwell's dystopian model of communication, a free will attached to free thinking remains at the level of those who are able to project the necessary "improvements of social organization". These projects are successfully embodied by public media in "world opinion, the marvellous unification of the public spirit"; the rest of the people are simply "dominated or swept by the wind of the opinion passing along" (*ibid.* p.136). In contrast to the dominating class, suggested by Tarde, in Orwell's *Oceania*, somebody "called upon to make a political or ethical judgement should be able to spray forth the correct opinions as automatically as a machine gun spraying forth bullets…" (Orwell 1949, *appx.*). In other words, the socio-political project is here closed as is Newspeak, perfectly adapted to their closed universe. Therefore, to the aforementioned "Orwell's problem" (as Chomsky names it), Newspeak offers a dystopian solution which in the long-term entails no coercion. Asymptotically similar, Chomsky offers a solution to the same problem within the form of liberal democracy:

> "Democracy permits the voice of the people to be heard, and it is the task of the intellectual to ensure that this voice endorses what leaders perceive to be the right course. Propaganda is to democracy what violence is to totalitarianism. The techniques have been honed to a high art, far beyond anything that Orwell dreamed of. The device of feigned dissent, incorporating the doctrines of the state religion and eliminating rational critical discussion, is one of the more subtle means, though more crude techniques are also widely used and are highly effective in protecting us from seeing what we observe, from knowledge and understanding of the world in which we live." (Chomsky 1986, 286)

1.3 Universe of forms: first step into Plato's problem

Turning back to the idealist stances referred to at the beginning, it is well-known that Plato's theory of forms – which offers a common ground for other idealists such as Augustine and Emerson – considers form (*morphē*) and idea (*idéa*) as something a-spatial and a-temporal, not in the sense of being everywhere, ever-lasting and incorruptible, but as being independent of space and time. It is the "participation" or "sharing" of an object in a Form (*méthexis*) that is properly dependent on space and time. This participation situates in the world of appearances (*phainómena*). When somebody – wishing real knowing – asks: "What is it?" (*tí esti*), he is intending to grasp from a limited spatial and temporal evidence, the a-spatial and a-temporal reality in the universe of forms (Augustine's "unchangeable" or Emerson's "unchanged essences").

The possibility of succeeding in such inquiry is grounded, on one side, on the limitation of forms (the aforementioned condition (i) of optimal reception) in contrast to the non-limitation of appearances (Augustine's "throng of phantasms", Emerson's "district of change"); on the other side, on the sharing of forms latent in the soul that allows real forms to be contrasted with corrupted ones (i.e., condition (ii) of optimal reception). These forms can be understood as "messages" sent from the otherworldliness of forms, which can be cleaned of appearances and phantoms – namely "noise" – by meeting these conditions.

If we wish to up-date Plato's conception of form to our current knowledge of order and disorder in our universe, the modern conception of information might assist the endeavor – as Weizsäcker pointed out (1971). From the current evolutionary point of view, forms evolve within the horizon of space-time in our evolving universe, whereas time itself is not regarded as something absolute and independent of the on-going processes, as it was for Newton or Kant. That is, instead of considering time as a precondition for the occurrence of events in a Euclidean space, it is the course of the on-going processes that brings about time in a space not necessarily Euclidian, but of an undecidable geometry according to any given experience (Zubiri 2001, Matsuno 1998, Capurro 2003).

However, from the point of view of the alleged conditions to the possibility of knowing stated within the Platonic tradition (which analogy to the conditions of optimal reception was previously highlighted), this inverted relation between form and time invalidates both: the universe of forms is in principle unbounded, and since these are not given once and for all, they cannot be shared *a priori* by those intending to know. In *communicational terms*: natural messages are spoken using a code that is not previously held by recipients. Whereas the "message universe for an optimal reception" is limited and given once and for all, messages in our open universe are unbounded and in continual evolution. Therefore, the given communicational model has to be superseded. To this end, and due to the lack of communality among codes, message production and transmission have to be more neatly distinguished from information.

2. Message vs. Information: two poles of a process

Message and information properly locate at the two extremes of the communicational process, on the side of the emitter and the receptor respectively. At the emitter pole, a meaning-offer (an intention) is made by emitting a message; at the receptor pole, a possibility of change is open to the messages that might be received. Thus, whereas the message is linked to the production of meaning and has an outward sense, information is linked to the malleability of the receptor having an inward sense.

Referring to the etymological roots of these terms, this character is already present in the original uses:

- "Message", as well as "emit" (and derived terms) come from the Latin verb *mittere* (past part. *missus*) which original senses can be translated by: sending; transmitting; providing (goods or thoughts); making something out of itself (leaves, roots, flowers; voice, words). Concerning its thematic flexion, while emitter refers to an active value, "message" has a rather "passive" one – corresponding to a concluded action, namely something emitted. Though the outward sense is to some extent inherent to the action referred to by *mittere*, in the case of "emitter", this value is reinforced by the Latin prefix "e-".[38]
- Concerning "information", whose historical evolution from its ancient roots to the modern scientific and common uses has been thoroughly studied elsewhere (Capurro 1978, 2009, Segal 2003, Díaz 2010), the etymological values already point to the act of modifying something (by giving form to either the mind, or some other tangible thing).

The flexibility of the information concept, provided by Mark Burgin's *General Theory of Information* – GTI (Burgin 2010), allows the most relevant uses of information, and particularly the sense that emphasizes the pair message-information to be comprised. From this overarching perspective, information is regarded as "information for a system" and referred to the "capacity to cause changes in" the system (Burgin 2010, 123-124). Taking the receiver as the system being addressed, information subsequently concerns the possibility of modifying the state of the receptor, where this modification can be of either epistemological or ontological nature. But it is important to notice the stress put on the "potential" character. If the change is produced, such potentiality is lost, the change has been exerted, and we say that the system has been "informed". Using the distinction introduced by Weizsäcker (1985), we can speak here about "*actual information*" in contrast to "*potential information*" (or plain "information" as commonly understood).

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[38] While English and Romance languages (as well as some others) have these common roots, the equivalents in other occidental languages – as Capurro (2008) has partially shown – broaden the corresponding semantic field, offering interesting nuances to the respective uses.

Concerning the confrontation of the pair message-information, the specific needs for emitting messages – on one side – and for seeking what is to be expected – on the other – arise from the more elementary – existential – needs of both the emitter and the receiver. However, it is not taken for granted that their respective offers and demands shall meet. An asymptotical nearing of both entails an activity, an effort, even a drama that cannot be grasped by the mere causality which is often appraised in most extended accounts of information.[39]

This asymptotic nearing corresponds – on the receptor side – to *interpretation of messages*, understood in a degree of complexity modes. According to the aforementioned relation of order and space-time in our open universe (§1.4), interpretation of messages evolves in time. Understanding a message originally means the very fact of being able to provide correct answers to the possibilities offered by this message in a given situation. This ability evolves "in time" from the rudimentary way of responding to messages to a more complex way of interpreting messages. At elementary stages, no difference is made in the interpretation process of messages between their syntactic, pragmatic and semantic aspects. The message brings forward in the receptor a determined response which normally depends on the state of the receptor, the given situation, and tends to provide some survival benefit.

2.1 Rudimentary interpretation: Objective response

Let us consider a simple case of messages and information in a cell in which the separation of all the components mediating in the process is minimal, for instance, the release of acid by means of proton channels at the cell membrane when the concentration of acid in the cytoplasm increases due to multiple reasons regarding cellular metabolism. These channels open when the pH gradient across the channels increases, enabling the release of acid until a healthy equilibrium is reached (Cherny et al. 1995). If this did not happen, the inner acids would depolarize the cell until it is dead. We can consider here the presence of a high concentration of protons at the channel as a "message" corresponding to a high concentration of acid in the cytoplasm. What is of most relevance to the survival of the cell is the high concentration of acid in the cytoplasm, not the presence of protons at the channel in itself. Furthermore, the response of opening the channels for releasing acid is determined not only by the presence of protons at the inner side of the channel, but in dependence on the concentration of protons at the outer side, namely the presence of a pH gradient. This comparison is crucial, since the

[39] A critique of this extended viewpoint has been carried out by the author in several contributions (Díaz and Capurro 2010, Díaz and Pérez-Montoro 2011a, 2011b)

real benefit of opening the channel is obtained when the concentration of acids on the outside is lower.

This response can be regarded as “objective” with respect to the cell, since this response is imposed on the cell when the gradient appears.[40] Therefore, though the response has a clear pragmatic value, the message carrier – the concentration of protons at the channel – (syntactic) and the response – opening the channel so as to allow the extrusion of protons until equilibrium is reached – (pragmatic) are directly linked. The “objective response” is determined by the physical and chemical structure of the channels, immersed in the specific situation of a membrane within a living cell surrounded by an appropriate environment.

The channel or the set of channels in the membrane have the possibility of being opened or closed, allowing the passage of protons, which has an obvious benefit if they are opened at the correct moment.[41] This ability is – so to speak – ready to be developed (i.e. to be informed) and it is the message mentioned that offers the key to opening the channels on the correct occasion. The inherent contrasting of concentration of protons across the channel by the channels themselves corresponds to the rudimentary interpretation of the message. Thus the message has an ambiguous potentiality to cause a positive change. The ambiguity is solved when the conditions for opening the channel are met. If this is the case, when the message reaches the membrane, the change is produced, and the membrane is actually informed. The subsequent diffusion of protons on the inside and outside of the cell will maintain the interpretation process. When the conditions change, the channel will be closed.

Though we do not have the footprints of the long-term evolution of this rudimentary interpretation process, we can guess that such evolution has enabled the concentration of protons at the membrane to be well interpreted in the sense of providing a survival benefit to the cell. That is, the meaning-offer at the emitter side and the meaning-need at the receptor side have to encounter a crossroad embodied in the physical and chemical structure of the proton channels. By this means the message can properly inform the receptor.

2.2 Interpreting reality: sensing the world

Concerning a more evolved interpretation of natural messages, we can say that instead of just sensing a stimulus that provokes an adequate response – as in the former case of “objective response” –, reality can be sensed by the

[40] Similarly, we can speak of “objective response” in the case of the finger immediately removed when it is pricked by the rose spine.

[41] As the timely opening by Maxwell’s famous demon is advantageous in the sense of increasing order.

receptor, which can act accordingly (Zubiri 1980, 47-67). To this end, the interpretation process requires a notable evolution in which: receiving the message as carrier moves in a syntactic terrain; attributing meaning in the semantic one; and acting accordingly in the pragmatic one. Though these three domains are of course interdependent, none of them can be reduced to the others (Díaz & Hofkirchner 2011).

The message, as denoted by its etymology, has the dual character of arising and arousing: (1) it arises from the reality of the emitter; and (2) by imposing on the reality of the receptor, the message arouses a response in it. It also has the character of a *restricted manifestation* of the reality of the emitter. In the case of natural messages, i.e., free of intentionality, this corresponds to the fact that only some parts of such reality have an effect on the emergent messages, for instance –remembering Emerson's words – some petals of the rose. In the case of intentional messages, the manifestation shall be restricted in order to improve the effectiveness in achieving the intended goals. As we will show below, this restricted manifestation is even imposed by the structure of our universe.

The response to a large proportion of these natural messages by the human (in a varied degree also the animal), instead of being "objective" – in the sense developed above –, has an intellective moment by means of which the manifested reality can be understood; what touches particularly on semantics.[42] Plato's and Orwell's problems clearly move in the terrain of semantics, but both are significantly concerned with pragmatics, asking how the given syntactic strata can support so well (in Plato) or so weakly (in Orwell) the semantic strata. To delve into Plato's problem, we can restrict the focus to natural messages attended to during observation, whereas Orwell's problem requires considering communication and co-operation.

3. Second step into Plato's problem: natural messages

When somebody is confronting an object of observation, and he asks himself: "What is it?" (*tí esti?*), this scenario must be modeled in correspondence to the relevance and nature of the interaction between the related object and subject of observation. This will allow us to analyze the limits of the manifestation (*phainómenon*) of the object the observer is asking for; thus the real space of

[42] As pointed out in note 4, the "objective response" also belongs to the repertoire of human responses, indeed to a high degree. Certainly, most of our somatic and visceral activity is regulated by inner and outer sensing unconsciously imposed, and frequently by means of a neuronal communication not passing through the cortex. However, it is a remarkable feature of our nervous system (in which evolved connexions coexist with more primitive ones) that the cortex holds the possibility of interfering with the "objective responses" – though with some delay. This is because the spinal cord transmits the sensitive impulses simultaneously upwards and downwards (Raisbeck 1954, Sobrino and Simón 1986).

meaning-offers, provided by the "natural messages", for interpretation by the subject.

3.1 Three observational approaches

As quantum mechanics has taught us, the interaction between object and subject is actually inherent to the nature of observation, therefore, in a strict sense, the classical picture of an external and neutral observation is not sustainable (Lyre 1999). However, in many practical cases the relevance of such interaction is so small that the classical observation – in the sense of not modifying either the object or its manifestation – can be regarded as sufficiently precise (model 1: ideal observation). We can even devise a model of interaction in which a classical approach can be used to give an account of the complexity of observation (model 2: classical interaction). But as far as we know, it is the quantum interaction that provides a more proper and exact account of the real interaction process (model 3: quantum interaction). Nonetheless, an exact account of what is really happening is strictly out of reach since the non-locality of quantum theory might bring us to the extreme consequence that we should consider the Universe as the collection of all physical objects into one and the same wave-function. Regarding this extreme theoretical stance, Heisenberg said: "… if the whole Universe were included into the system, the physics would disappear, leaving only a mathematical schema" (Heisenberg 1930, 44 – my translation).

For the sake of simplicity, we have restricted our scope here regarding a simplified situation constituted by an object and a subject of observation immersed in a homogeneous and isotropic space surrounded by emptiness. Figure 2 illustrates this case of observation according to classical models – ideal and interactive; whereas Fig. 3 adapts the observation problem to a scenario of quantum interaction.[43]

[43] Though in previous contributions the author has analysed the problem described by model 1, this extension to the interaction with the object – in classical and quantum scenarios – is in debt to the constructive criticism of Gerald Luhn (Technical University of Dresden) as argued in the congress FIS-2010, Beijin, where the author exposed the corresponding analysis (Díaz and Pérez-Montoro 2011b).

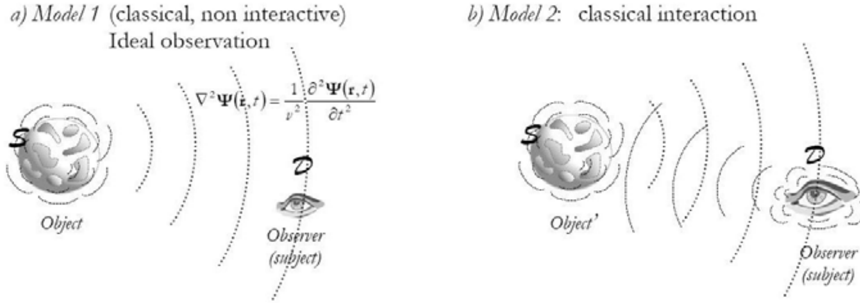

Figure 2: Classical observation: a) ideal observation (valid for cases of weak interaction, e.g. far-observation); b) classical interaction in which the energy detected by the observation system acts as a new source affecting the object.

Ideal observation. Although the ideal observation (Fig. 2.a) is not exact, the model might be accurate enough when the intensity of the interaction is so weak that no significant difference is produced, for instance, when the observer is far off and its dimension is small with respect to the distance between relevant differences of the wave phenomena. In this case, the structure of the wave phenomena $\boldsymbol{\Psi}$ occurring in the space surrounding the sources –which is supposed homogeneous– is described by the wave equation as represented in the figure, and the changes produced in the observation means are in direct relation to this phenomenon. We will later on delve into this case in order to investigate the limits of the meaning-offer provided by the manifestation of the object. Since this situation constitutes an ideal case of observation, the related limits represent an outer boundary within which the interactive models might provide further constraints. But, before going into these details, let us look into the other models.

Classical interaction. For the classical interaction (Fig. 2.b), and as we will later see, the relation between the object-domain and observation-domain can be interpreted in a recursive way using the linear relation between a set of equivalent sources properly distributed over the surface surrounding the object $\mathcal{S}$ and the phenomena which in turn correspond to a set of equivalent sources over the observation domain $\mathcal{D}$. These equivalent sources at the boundary of the observation system affect the object sources by means of a new wave phenomenon, producing a transformed set of sources – slightly different from the former ones. In subsequent iterations the set of phenomena at the boundary of the observation domain, and the set of sources will asymptotically tend respectively to what has been observed and the modified object. To some extent, the observed phenomena are directly related to the modified object, not to the object as it was before being observed, although this can be figured out. Despite this invertibility, and concerning the interaction, what is really important is that the object has changed, and the fact that it is something inseparable from such interaction at this moment. However, it is also true that from this classical point of view the initial state could be recovered.

Quantum interaction. Something else happens with the quantum interaction (Lyre 1998; Vedral 2006). Here the object and the observing systems – formerly in an original state in their respective Hilbert spaces κ_1 and κ_2– mix into a new quantum system in the product Hilbert space. The state of this mixture $|\Phi\rangle$ (a pure state with a projection operator $\hat{P}_\Phi$) is changed by the measurement interaction into another pure state $|\Phi'\rangle$ by means of the Hermitian operator corresponding to the observable being sought. Right after and to make the observation possible, both systems must be separated again. After this separation, the states of both systems are no longer pure, but improper mixtures which can be described by density operators. These mixed states $\hat{\varrho}_\psi$ allow an infinite number of decompositions into states $|\psi_i\rangle$. Selecting one of these decompositions, the improper mixture turns into a proper mixture described by $\hat{\gamma}_\psi$, i.e. the collection of possible pure states and the corresponding probabilities. Finally, one of these possible pure states is determined by observation at the subject system which is linked to the value of the object observable (for which the observation system was prepared, i.e. some observable can be determined while other observables are left aside).

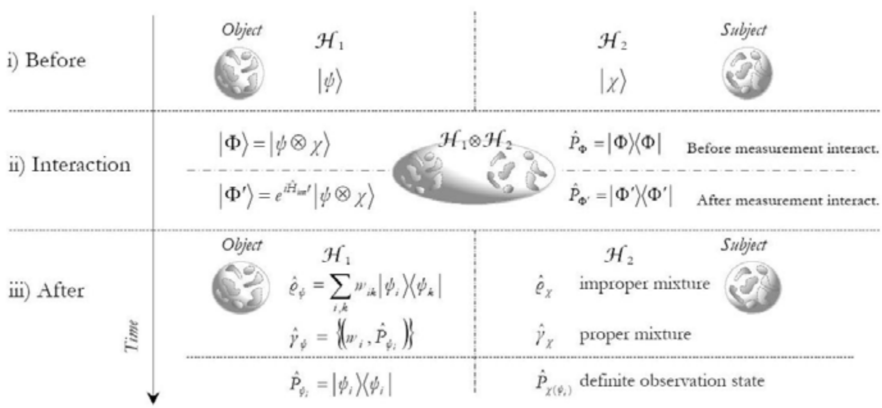

Figure 3. Observation model 3 of quantum interaction.

In this process, it is worth mentioning two relevant features: i) by observing the object, it is changed in an irreversible way; ii) some characteristics of the former states get to be scarcely known or completely unknown. In other words, as in classical observation (models 1 and 2) the object cannot be completely determined; but unlike classical observation, the object is here irremediably changed, making further inquiry into the original state unfeasible. We can also say: the subject has become materially “informed” about some features of the object, which in turn has also been “informed” by the interaction. Neither of them will get to be the same after observation. Before the observation, the wave function of the object system represents a catalogue of what might be potentially measured (i.e. changed) in the subject regardless of how it is, and where it is located. However, the observation system will necessarily be prepared to be affected by a restricted catalogue of characteristics of the object. While the former catalogue can be understood as meaning-offer of the object (we can name “potential messages”), the latter corresponds – following Weizsäcker – to “*potential information*”, since it refers to potential changes in a specific receptor system (thus mere *information* in the sense of GTI). After the observation, the subject has been changed according to how the object and the subject were, and how they came into interaction. In other words, the subject has been actually informed; it holds “*actual information*” (Weizsäcker, 1985).

3.2 Analysis of natural messages in the case of ideal observation

The aforementioned model 1 of observation, though it may not suffice to give a proper account on the “actual information”, will be very useful for delving into the limits of “potential information” and for probing the indeterminacy of the object.

Seizing the observation problem. Given the simplifications of the observation scenario previously assumed, when an observer gives attention to the manifestations of an object (no matter whether they are due to mechanical or electromagnetic interactions with the environment, as in the case of sound or light respectively), the observing properties of such an environment respond – where the observer is located – to the well-known wave equation:

$$\nabla^2 \mathbf{\Psi}(\mathbf{r},t) = \frac{1}{v^2}\frac{\partial^2 \mathbf{\Psi}(\mathbf{r},t)}{\partial t^2} \tag{1}$$

where $\mathbf{\Psi}$ represents the properties of the environment to which the observer is allegedly sensitive (e.g. air pressure or light), $\mathbf{r}$ is the position vector, t the temporal variable, and v a constant depending on the environment characteristics that is equal to the propagation speed of the wave phenomenon (c, in case of vacuum). This equation represents the structure of the wave phenomenon (i.e. the leeway and constraints imposed by the very nature of the physical space where the phenomena take place). Its pertinence requires that the space where the equation is locally verified is homogeneous and isotropic (i.e., the interactions are independent of either the direction or the position of the related parts). This includes, according to the aforementioned conditions of ideal observation, the domain of observation $\mathcal{D}$ and also the surface bounding the object $\mathcal{S}$, but not the region where the inhomogeneities of the object are located, where instead D'Alambert's equation is valid.

The relative complexity of eq. (1) may be smoothed if the distribution over space-time is expressed: (a) as a linear combination of sinusoidal variations at each of the space and time dimensions, (b) restricting the set of sinusoidal variations to those with physical significance for the given problem: outward waves which do not immediately vanish in the vicinity of the observed object. By virtue of the Fourier theorem, (a) does not imply any loss of practical generality, and (b) is justified by the conditions of our problem and the selection of an origin of coordinates within the observation object. Therefore the space-time distributions of the wave phenomenon – corresponding to the observation problem – take the following form:[44]

$$\mathbf{\Psi}(\mathbf{r},t)=\sum_{\{\mathbf{k}\}}A_{\mathbf{k}}\mathbf{\Psi}_{\mathbf{k}}(\mathbf{r},t)=\sum_{\{\mathbf{k}\}}A_{\mathbf{k}}\prod_{u=x,y,z,t}e^{-ik_u u} \quad (2)$$

where $A_k \in$ □ in order to express the amplitude and phase of the sinusoidal variations (though only the real values of $\mathbf{\Psi}$ have physical meaning); $\mathbf{k}=(k_x,k_y,k_z,k_t)$, being k_u the wave length number for any of the space-time dimensions (i.e. 2π times the number of cycles per coordinate unit) and $\{\mathbf{k}\}$ the set of valid wave length numbers for the given problem.

*Dimensional analysis***.** Applying solutions of the type (2) to equation (1) and restricting the time-frequency to a fixed value *f*, we obtain a restriction defining the aforementioned set of valid wave lengths:

$$k_x^2+k_y^2+k_z^2=k^2 \quad (3)$$

which correspond to a sphere or radius $k=2\pi f/v=2\pi/\lambda$ (λ standing for the wavelength of the frequency involved if it only propagates in one direction). If we consider *f* as the maximum frequency value (for example, the sensing bandwidth), equation (3) transforms into: $k_x^2+k_y^2+k_z^2\le k^2$ (4'), i.e. a ball of radius *k*. Relation (3) or (3') means that the sinusoidal variations that may be expected in each spatial direction are fundamentally bounded. In the case of a given frequency, eq. (3) means that the maximal wave number in any spatial direction cannot be bigger than *k*. If we apply the sampling theorem to this conclusion (Kotelnikov 1933, Shannon 1949) we straightforwardly arrive at the *sampling theorem for radiation fields* – $\mathbf{T_1}$ (Díaz and Pérez-Montoro 2011b):

[44] The wave phenomena through which the object manifests can be originated by: (i) the object itself, if it is composed by active sources (as happens with a radiating object), or (ii) by means of illumination. In the latter case, the observed radiation is composed by the illumination itself, usually a plane wave, and the scattered field, which is dependent on the time-space inhomogeneities introduced by the object. Since these two components can be separated, and the second is the one actually holding significant variations and higher complexity, attention will be given only to the scattered field, which can be treated as an equivalent problem of type (i). Thus, in this analysis – and without loss of generality – problem (i) is analyzed.

> The minimal distance between independent values of a field by an arbitrary object is *λ/2*

which is valid for any observation domain $\mathcal{D}$ for which eq. (1) is verified.

By applying T_1 to the object boundary $\mathcal{S}$ where eq. (1) is still verified, and by considering the uniqueness theorem for this equation, we immediately arrive at the *essential dimension theorem for the manifestation of a bounded object* – $\mathbf{T_2}$ (*ibid.*):

> The maximum number of details that are reflected in the wave phenomenon of frequency *f* through which an object, inscribed in a sphere of radius *a*, is manifesting in its surrounding space is equal to its essential dimension: $N=16\pi(\tau af/c)^2$.

where $\tau \geq 1$ stands for an excess of the maximal spatial frequencies with respect to $2\pi/\lambda$ at $\mathcal{S}$.[45] In case the frequency of the wave phenomenon is not restricted, but assuming instead a bandwidth *f*, determined by either the observer or the object, the essential dimension can be calculated considering that: (i) instead of the surface of the sphere of radius *k* in the space of spatial frequencies, the volume of a ball of the same radius shall be considered; (ii) the separation between independent spatial frequencies is π/a, which sets an independent volumetric region of size $(\pi/a)^3$. Proceeding as in (*ibid*): $N'=32\pi/3(\tau af/c)^3$.

Whereas the former value, *N*, represents the essential dimension for a static observation of the object at a given frequency, the latter value, *N'*, might correspond to a dynamic observation, since allowing a space of frequencies is equivalent to allowing temporal variations.

Finally, if we now add the restriction of positioning the observer with respect to the observation object at a distance *d* from the centre of the sphere containing the object, the *sampling theorem for distant observation* – $\mathbf{T_3}$ (*ibid*) can be proven:

> 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: $\lambda d/2a\tau$.

Forward problem. Assuming we know the distribution of the inhomogeneities corresponding to the object (i.e. the description of the object concerning manifested properties), we can express the manifestation of the object in the observation domain considering those inhomogeneities as sources of the wave phenomenon. For the sake of simplicity, this description of the object can be expressed as a set of Dirac delta distributions of different amplitude and position (expressing discontinuities where punctual sources locate):

45 This excess is due to the fact that in the vicinity of the inhomogeneities some evanescent modes might propagate. The determination of this parameter depends on the error that is admitted when the actual distribution is approached by a set of punctual sources on $\mathcal{S}$.

$$\mathbf{s}(\mathbf{r}) = \sum_{i=1}^{N_O} s_i \delta(\mathbf{r} - \mathbf{r}') \quad \text{where } \mathbf{r}'\text{: position of the punctual source } i \tag{4}$$

Thus, it is the set of N_o amplitudes and positions that completely describes the object (N_o being arbitrarily large). The field generated by each of these punctual sources can be expressed by the Green function G(***r***) that satisfies at the same time the wave eq. (1) – at the observing domain – and the D'Alambert equation – at the discontinuities represented by δ. In virtue of the linearity of eq. (1), the manifestation of the object – described by (4) – can be simply determined as a linear combination of Green functions:

$$\mathbf{\Psi}(\mathbf{r}) = \mathbf{s}(\mathbf{r}) * G(r) = \sum_{i=1}^{N_O} s_i G(\mathbf{r} - \mathbf{r}') \tag{6}$$

Re this forward problem (indeed a pseudo-problem), we do not care if N_o is bigger or smaller; knowing the source, no matter how complex it is, its manifestation can be straightforwardly determined.

Inverse problem. Properly, Plato's problem is stated on an *a posteriori* basis, that is, reckoning with its manifestation. This is the so called *inverse problem*, which in our formulation implies obtaining **s**(**r**) given **Ψ**. To this problem, the theorems stated above will smooth the course: according to T3, the actual dimension of the observed phenomenon does not depend on how detailed the observation is, since we often have to move to quite some distance to find some independent value of the phenomenon considered. This means that without any loss, we can just gather a number of samples *M* properly deployed around the object and distanced from each other – the evidence provided by a limited but well-selected set will be no smaller than endlessly moving around the object collecting more and more data. Furthermore, according to T_2, the number of spatial details we can maximally perceive about the object can never be higher than its essential dimension *N*. Therefore, in order to at least recover that number of details, the number of collected data has to be at least so big, i.e. $M \geq N$.

But before any other comparison, it is relevant to remind ourselves – regarding the essential dimension – that it does not depend on the volume ($\propto a^3$) but on the bounding surface ($\propto a^2$). This lets us arrive at a fundamental conclusion: the volumetric distribution of the object is inscrutable. In this case, what might we know about the object?

At this point, it is worth remembering Huygen's principle (1690) –which can be justified through the uniqueness theorem of the wave equation (1). It establishes that "each point on a primary wavefront can be considered to be a new source of a secondary spherical wave and that a secondary wavefront can be constructed as the envelope of these secondary spherical waves." Thus, it suffices to refer to the secondary sources (or *equivalent sources*) distributed on the surface bounding the object $\mathcal{S}$. As we have just shown, the dimensionality of the observation and that of the radiated field around the object implies that we can only obtain from the object a superficial knowledge, which can be interpreted as a projection of what is inside. But it is forbidden to come into that "inside" based solely on *a posteriori* knowledge.

To clarify this last condition, we must take into account that if the inner complexity of the object structure is smaller than the essential dimension $N_o<N$, then the observer might grasp an idea of the volumetric distribution. However, since there is in principle an unlimited number of inner structures whose projections over a bounding surface are equivalent, such an 'idea' should be achieved based upon some assumptions or a priori knowledge of the inner structure.

Considering the separation required for the independence of the equivalent sources at the bounding surface (here translated into the independence of the fields generated over the observation domain, $\mathcal{D}$): a good way to render our problem well-posed is by locating N punctual equivalent sources over $\mathcal{S}$ regularly spaced at a distance $\lambda/2\tau$:

$$\hat{\mathbf{s}}(\mathbf{r}) = \sum_{i=1}^{N} \hat{s}_i \delta(\mathbf{r} - \hat{\mathbf{r}}') \tag{6}$$

The space of equivalent manifestations, generated by these equivalent distributions **s**, is equivalent to the eventual manifestation of an arbitrary inner (discrete or continuous) volumetric distribution:

$$\hat{\mathbf{\Psi}}(\mathbf{r}) = \hat{\mathbf{s}} * G(r) = \sum_{i=1}^{N} \hat{s}_i G(\mathbf{r} - \hat{\mathbf{r}}'_i) \quad \equiv \quad \mathbf{\Psi}(\mathbf{r}) = \mathbf{s} * G(r) = \sum_{i=1}^{N_O} s_i G(\mathbf{r} - \mathbf{r}'_i) \tag{7}$$

It can be shown (Díaz, 2003, §3.2.1) that if a metric and a distance among field distributions are defined for the abovementioned space of radiated fields, then there will only be a unique distribution of equivalent punctual sources **s** that matches the observed phenomenon[46]: $\hat{\mathbf{s}}(\{\hat{\mathbf{r}}'\}) = \mathbf{\Psi}(\mathbf{r}) * \mathbf{G}^{-1}(\mathbf{r})$.

3.3 Observational limits: the ambiguous meaning-offer of natural messages

Using the terms in which the problem has been stated above, eq. (4)-(7), Fig. 4 illustrates the essential ambiguity of the meaning-offer of the object's manifestation.

[46] It corresponds to an orthogonal projection of the observed manifestation $\mathbf{\Psi}$ on the space of equivalent manifestations $\hat{\mathbf{\Psi}}$. A more detailed expression, given in matrix form, is provided in (Díaz 2003, Díaz and Pérez-Montoro 2011b). The existence of such projection: (i) is related to the independence of the wave functions of each equivalent source situated on the bounding surface $\{\hat{\mathbf{r}}'\}$; (ii) is unique for each valid set of equivalent sources, defined by $\{\hat{\mathbf{r}}'\}$.

Reality	$\mathbf{s}(\mathbf{r}) = \sum_{i=1}^{N_O} s_i \delta(\mathbf{r} - \mathbf{r}')$	
Message (manifestation)	$\boldsymbol{\Psi}(\mathbf{r}) = \mathbf{s} * G(r) = \sum_{i=1}^{N_O} s_i G(\mathbf{r} - \mathbf{r}'_i)$	$\hat{\boldsymbol{\Psi}}(\mathbf{r}) = \hat{\mathbf{s}} * G(r) = \sum_{i=1}^{N} \hat{s}_i G(\mathbf{r} - \hat{\mathbf{r}}'_i)$
Meaning-offer		$\hat{\mathbf{s}}(\{\hat{\mathbf{r}}'\}) = \sum_{i=1}^{N} \hat{s}_i \delta(\mathbf{r} - \hat{\mathbf{r}}') = \boldsymbol{\Psi}(\mathbf{r}) * G^{-1}(\mathbf{r})$
	Reality and Manifestation of the emitter (object)	What is offered to the receptor (subject) concerning the object

Figure 4: On the left, spaces of (supposed) reality and manifestation of the emitter (object), if its complexity is constrained to N_o punctual heterogeneities; on the right, spaces of message and meaning-offer on receptor (subject) side, whose complexity is constrained to N punctual heterogeneities. The real structure of the object (here determined by N_o values and positions) remains veiled to the subject, whereas a projection in the space of N punctual heterogeneities can be achieved.

According to the previous analysis, the following fundamental conclusions can be forward-extracted concerning what can be maximally known about the object causing an observed wave phenomenon. In other words, what is the *actual "meaning-offer" of the "natural messages"* coming out of the object to their interpretation by an observer aiming at answering: what is that in front of me? (*τί ἐστι;*):

1. The number of details to be found in the environment due to the presence of the object is finite (~*N*).
2. Such number depends on the surface bounding the object and not on its volume.
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 a bounding surface.

These four conclusions establish fundamental limits on the observation problem, not related to the specificity of our organs of animal or human sensibility, but to the differences that can be found merely in the environment and the maximal knowledge that might be derived about the object causing these differences only based upon them.

Using Kantian terminology, these are the limits in the determination of an object of knowledge by means of a transcendental subject, to which intimate knowledge of the object is withheld – as we previously showed. In other words, in spite of the actual complexity of the object (~N_o), the complexity of its manifestation (~*N*) is constitutively smaller than the possible complexity of the object, which is in principle unbounded. We could argue that this is the case unless the object is completely described by its projection over the bounding surface (i.e., $N \geq N_o$). But even in this case, observation does not suffice to conclude that this completeness is the case; we must also know, for instance, that the inner part is empty, since there is a whole set of possibilities regarding the inner configuration.

Our analysis might be considered trivial if we just think of its correspondence to the visual problem, since there is a danger of confusing the limits to knowledge of the inner part of an object with its opacity. Even if some degree of transparency could be ascribed to all the inner parts, the limit concerning the complexity of the field generated by the object leads us to the same conclusion: the three-dimensionality of the inner distribution cannot be determined by the two-dimensionality of the object manifestation.[47]

3.4 Interpreting natural messages beyond the limits of the meaning-offer

As previously pointed out, the completeness in the determination of the object by observation requires that the observer only intends to find out the specific configuration of an object whose degrees of freedom are equal or less than the complexity of the field in the surrounding space (i.e., $N \geq N_o$). However, since the observation itself does not provide enough bases to conclude that such limitation of degrees of freedom is the case, this requirement thus implies an important amount of previous knowledge, good luck or good intuition.

As stated in the above observational limits, the observer cannot get into the very object, since "natural messages" hold a fundamental ambiguity with respect to the reality whence they come. However, as in the case of Plato's captive, who tries to go beyond the "shadows which the fire throws on the opposite wall of the cave" (Plato, *Resp.*, B.7, 515a), the observer of our problem also tries to go beyond the ambiguity of the manifestation of the object, into the object itself. If something about the structure of the object – leaving a degree of freedom less than N – were previously known, guessed or intuited, this set of assumptions can be interpreted as the code of the natural message. If the receptor holds it, the message can be disclosed and the "throng of phantasms" of the object's manifestation can be dispelled, enabling the very

[47] Similarly, Bekenstein (2003) states – based upon the holographic principle, proposed by Susskin – that if the physics of our real (tetra-dimensional) universe were holographic, there would be an arbitrary set of physical laws which could be applied to some tri-dimensional space-time boundary – corresponding to the horizon of experience. Therefore, there is a radical indeterminacy between this *holographic universe* – as Bekenstein calls it – and the physics we use to interpret it. The *holographic principle* states that the maximal entropy contained in a limited space depends on the bounding surface and not on its volume (Susskind 1997, Díaz 2010b). This value is finite and equal (in bits) to ¼ the number of Plank areas contained in the bounding surface.

object to be reached; though this is only the case if the so called "code" is correct. If the complexity of the manifestation seemed to be N – before knowing how the object was inside the ball of radius a – after having he code, the actual complexity is revealed to be N_o.

As mentioned in § 1.4, the Platonic solution implies, on the one hand, a limitation of forms – parallel to the limitation of degrees of freedom here stated –; on the other hand, the latency of these forms in the receptor – parallel to having the code of the natural messages. In terms of Shannon's information concept, N_o corresponds to the information the receptor needs in order to determine which message was sent within a finite set – a posture therefore aligned to the Platonic closed universe of forms. This information thus equals the uncertainty of the receptor and provides a perfect match between the meaning-offer of the natural messages and the information-need of the receptor.

Nevertheless, as we have previously argued (§1.4), forms evolve in time instead of being a-temporal, and they are in principle unbounded. Thus rather than admitting a Platonic solution, we have to consider that the observer receives messages for which he does not have their corresponding codes. Since the observer tries to go beyond the ambiguity of natural messages in order to unveil the object's reality, he searches for a code enabling him to understand the message. If the observer succeeds in finding out that the complexity of the manifestation is much smaller than N (through guessing or acknowledging an object structure of such reduced complexity which enables the whole manifestation to be reckoned), then the receptor can feel he has touched the object; particularly, if he intuits there is no way to provide a more simple description. In this case, we can say the meaning-offer of the natural message has converged with the information-need of the receptor; the message has been disclosed and with the unveiled reality "arises a pleasure mixed with awe" (Emerson 1836, 36); though unlike in the Platonist tradition, it is not related to having reached the eternal *kósmos*, but the very near reality of the object.

Nevertheless, concerning this unveiling, and following Plato, we can speak of an erotic moment, whose genealogy –as depicted by Diotima (*Symp*. 203b-e)– is rooted in the conjunction of *Poros* (Plenty) and *Penia* (Poverty). In our case, this join is referred to the convergence of the meaning-offer of the message and the information-need of the recipient, not by means of a celestial love (*éros ouránios*) – as preferred by Pausanias (*Symp.*, 180c) – but a terrestrial one (*éros epichthónios*, paraphrasing Pausanias), which imposes an active and often creative search for the simplest description of the object causing an observed phenomenon.

Regarding this optimal description of the object, one can easily note it is close to *Kolmogorov complexity* of the object (Burgin 2011). In fact, if the smallest description of the object is achieved, this properly corresponds to Kolmorov Complexity or *Algorithmic Information*. And it is known that –

according to Turing's halting theorem – there is no recursive method to decide if the minimal description is actually achieved (Salto 2010).[48] Similarly, our dealing with the world shows that there is no achieved perception or awareness about a state of affairs being beyond review or critique. Hence our process of removing flaws from our awareness and knowledge about the object can be regarded as an open dialectical path. However, in contrast to the eventually finite series of proper questions driven by eternal forms in Plato's dialectic (*διαλεκτική* and *διαίρεσις*), the corresponding dialectical approach to the observation object in our open universe is an open and indefinite path.

Therefore by means of the aforementioned relative success in the interpretation of natural messages (when finding a description of the object of complexity $N_o?N$), the sensed reality remains *open* in two different senses: (o1) the possibility to make a more economical description is open – i.e. we might always intend to apply again Occam's razor aiming at removing another veil of the object –; (o2) some details of the object might remain completely un-manifested for the given observation, because they did not have an effect on the observed phenomenon (for example, in microscopy, more details can be grasped if the observation frequency is increased, thus manifesting what in lower frequencies was not perceptible). In other words, although by interpreting natural messages beyond the ambiguity of their meaning-offer, the observer gets to sense reality, he also senses that this reality is open, insofar as it always points to further completion by either a better seizing of the object (o1- *intensive* sense) and by a more detailed description (o2- *extensive* sense).

4. Reconsidering Plato´s problem: second step into Orwell's problem

Angelorum autem vocabulum officii nomen est, non naturae.
Semper enim spiritus sunt, sed cum mittuntur, vocantur angeli.[49]
Isidore of Seville (627-630)

Hitherto, we have analyzed natural messages considering their nature in terms of the physical structure of the object's manifestations. These manifestations can be regarded as the *angels* of the things being observed, and their natures can be fundamental to accomplishing their missions – as the winged sandals for a timely coming down from Olympus – but this nature may just offer leeway and constraints, which do not explain the development of their very missions. To focus on them, we need to broaden our observation model.

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48 According to Burgin, this boundary could be overcome by using Super-Recursive Algorithms, for instance, by means of inductive Turing machines (Burgin 2005).

49 Isid., *Etym.*, VII, 5, 2: "The term for angels is thus the name of their function, not of their nature. Indeed they are always spirits, but when they are commissioned they are called angels" (transl. Barney 2006, 160)

4.1 Broadening the worldliness of natural messages

Jumping over the boundaries stated in the previous section for delving into Plato's problem (concerning the observation of an object in an isolated circumstance) to considering the object and the subject immersed in a real context, the aforementioned openness of our sensed reality (§3.4) broadens significantly. The relation to the environment is observed as constitutive of the object, as well as the subject. Things always point to the system of things in which they are immersed in a reflexive dependency (this is placed on that, that is supported by this; this is behind, that is nearby; and so forth). Hence, in contrast to the *otherworldliness* and *limitation* of forms acknowledged in the Platonic vision, this viewpoint of dealing with natural messages in order to grasp reality deals with the *worldliness* and *openness* of sensed reality, in which whatever is being sensed can always be better unveiled and completed, not only by new observations of the object itself, but also by new and fundamental relations to the environment. This corresponds to a new sense of openness with respect to the two senses referred to above that we will denote as (o3).

Nonetheless, though this openness and worldliness can be sensed as a constitutive element of the observed objects, the pragmatic situation impels the interpretation process in a different direction, asking for a new kind of Occam's razor which is different from the one devoted to polishing the description of the object as depicted in §3.4. This new sort of Occam's razor, or complexity reduction, is fundamental to providing an existential orientation in the observer's world, and it has to be exerted in opposition to the extensive sense of openness (o2) mentioned above. Whereas *complexity reduction* – as considered in §3.4 – had to deal exclusively with the antagonistic pair of intensiveness (o1), provided by the simplest description of the object, and extensiveness (o2), provided by observations of the object, now, a new antagonistic vertex appears, corresponding to the reality in which the object is immersed in a participative way – i.e. the object cannot be described in isolation since it forms part of a wider reality (o3). This triad – represented in Fig. 5 – imposes equilibrium among the brevity of the description, exhaustiveness in the details of the observed object, and exhaustiveness in its environmental relations. And this equilibrium has to be pursued – and achieved relatively– under obvious pragmatic constraints (including space-time limitations). But how can it be specifically achieved?

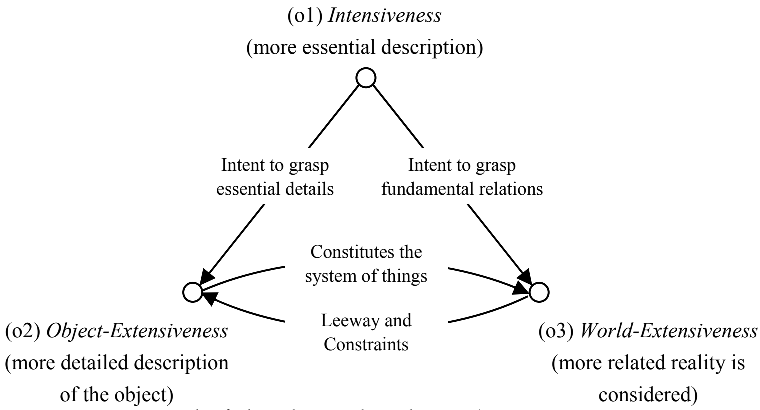

Figure 5: Openness triad of the observed reality. o1) intensive sense: a more essential description is possible; o2) object-extensive sense: more details can be included; o3) world-extensive sense: more reality is referred to.

4.2 Between Funes' exhaustiveness and Plato's otherworldliness

The necessity of finding the aforementioned equilibrium – particularly under pragmatic situations – can be symbolized negatively by the "hopelessly crippled" "Funes the Memorious" – Borges' fictional character, who was "the solitary and lucid spectator of a multiform world which was instantaneously and almost intolerably exact" (Borges 1942, 90). In contrast to Funes who could remember absolutely any instantaneous nuance of his experience, and who therefore moved on the side of the triangle defined by (o2) and (o3) (namely the two kinds of extensiveness), we often wish to grasp the very reality behind its manifestation, i.e. to decode the natural messages; or – in other terms – to know about the reality concerned (not simply disregarding the manifestations as in the Platonic tradition, but considering these as the filled space that allows us to touch reality itself). And furthermore, not lying in the bed as Funes, we urgently need to find orientation in our very existences for coping with our practical problems. This gives rise to a new type of information-need with respect to the one considered in sect. 3, which comes to complete it in the search for convergence with the meaning-offer of the messages. Whereas the intention to grasp reality might require delving into the details of the object, the need for coping with our practical problems requires grasping the fundamental relations of the object with respect to the world in which both the object and the subject are immersed. But, how is it possible after all to move from the side defined by (o2) and (o3) in which we have situated Funes' awareness?

According to our previous analysis, if reality does not manifest itself completely so as to identify unambiguously what is behind, what is in common among different things, how they relate to each other…, then we may ask: What mechanism do we use to infer the reality behind its manifestations, the communality of things, the leeway and constraints defined by the system of things – all of which are of significance for our dealings with the world?

Plato's solution. From Plato's point of view, the order is found because the underlying forms of the universe were already latent in the observer. And similarly to how our optimal receptors (designed according to Kotelnikov, §1) compare received messages with each of the possible ones, whoever intends to gain knowledge makes an analogous comparison with forms by means of proper questions. The kind of inference for deciding the correct answer is *deductive*: for each possible form, the likelihood of its being the case is deduced. If the universe of forms were open, this set of deductions would have a minor value because an infinite comparison is unfeasible. However, if the universe of forms is finite – according to Plato –, there is nothing more reasonable to admit than the actual form of the object is the one with maximum likelihood – as our optimal receptor does.[50] In case the receiving conditions are appropriate, truth is practically achieved, though relative to the finite otherworld.

Aristotle's solution. In contrast to Plato, Aristotle advocated observing reality in order to grasp generic essences inductively. In the particular case of finding the natural system of living species – to which Aristotle devoted an astonishing observational effort –, he considered that true knowledge comprises knowing the essences of things, its internal character expressing what things really are despite their multifarious appearances. By knowing the true essence of species, the naturalist would be able to classify them comparing and contrasting the essential characters. However this constitutes the previously considered deductive inference (by means of *apódeixis* or *apodeictic syllogisms*) that allows rather demonstrations from given knowledge than the achievement of knowledge itself. The essences are the worldly correlate to Plato's forms, and insofar as they are not in the otherworld, Aristotle postulated searching for essences through *inductive inference* (the *epagōgḗ* to which Plato had already referred in a different and informal sense). Nevertheless, Aristotle doubted the real ability of the naturalist to find such essences by careful observation (Bowler 1992). Hesitation that is well-founded since, being aware – as he was – of the

[50] In optimal receptors a set of operations is performed which, taken together, is equivalent to the set of deductions for determining the likelihood with respect to each possible message and picking up the maximum.

boundlessness of changing manifestations, there is no sure means to identify the essences unless they were previously known – as in Plato's solution.

The unfeasibility that the meticulous naturalist finds the essences – thus the constitutive elements of the systems of nature – was later on proved by the historical development of such systems, particularly in the eighteen century. Then the careful observation of nature brought about an unbridled proliferation of species. Linné's "Systema naturae" (1735) represented a significant step in such development, but it was not at all isolated, neither did it seem to be definitive (Bowler 1992).

The aporetic character of induction to find essences – when observation becomes exhaustive – can also be illustrated by the extreme case of Funes, whose overwhelming faculty of sensing deprived him of the possibility of finding any essence:

> Locke, in the seventeenth century, postulated (and rejected) an impossible idiom in which each individual object, each stone, each bird and branch had an individual name; Funes had once projected an analogous idiom, but he had renounced it as being too general, too ambiguous. In effect, Funes not only remembered every leaf on every tree of every wood, but even every one of the times he had perceived or imagined it. [...] He was disturbed by the fact that a dog at three-fourteen (seen in profile) should have the same name as the dog at three-fifteen (seen from the front). His own face in the mirror, his own hands, surprised him on every occasion. (Borges 1942, 89)

Summarizing, both deduction and induction seem to be incapable of getting out of the extreme positions of the triad depicted in Fig. 5 defined by intensiveness (though in a closed sense) and extensiveness (of both types) respectively.

Peirce's solution. A third inferential path, which might allow us to understand the convergence of the meaning-offer of natural messages and the information-need of the observer, was proposed by Charles Sanders Peirce, namely *abduction*: "the process of forming explanatory hypotheses; […] the only logical operation which introduces any new idea" (Peirce 1977, 5.172). This process can also be ascribed to the intuition of order by the observer referred to in section 3.[51] As we saw, the observer must pose – in order to find the essentiality of things behind its manifestations – the correct questions in relation to what is not yet being determined in the supposed structure of the object immersed in the world – thus similarly to the Platonic observer. But rejecting the latency of forms that might drive the appropriate questioning, these have to be creatively searched out among the practically boundless questions. Following Peirce, Umberto Eco considers that the code enabling us to interpret some observed reality (i.e. disclosing the natural messages) is

51 Although Peirce considered that "abduction is, after all, nothing but guessing" (Peirce 1977, 7.219), he was not clear about the nature of such guessing or its eventual justification. He spoke, for instance, of "kind of instinct", "natural affinity for truth"… (Torretti 1999).

discovered through *creative abduction* (Eco 1990, §1.11).[52] Such discovering – as stressed by Eco – plays a crucial role in sign production: after the code is discovered and contrasted, "any ulterior manifestation of the same phenomenon is transformed into a sign which progressively becomes more necessary" (Eco 1990, ibid). And this will be taken as a sign of the corresponding orderly reality – unless until some manifestation eventually disqualifies it.[53]

Therefore, in the creative inference of the essential characteristics of observed reality as well as in the creation of codes facilitating the interpretation of the observed reality after the creative moment, abduction plays a fundamental role in our dealing with a world in which the underlying structures are in principle unbounded and evolve over time. As Rainer Zimmermann points out, creative abduction – or *associative abduction* as he also names it – constitutes a fundamental "condition of effectively reducing complexity in order to find orientation within the world" (Zimmermann 2011, 67).

In the case of the aforementioned explosion in the complexity of natural systems along with early developments in modern biology: the reduction of such complexity was first vaguely announced by Buffon in 1749, later approached by Lamarck at the beginning of the 19th century, and finally achieved by Darwin's theory of evolution in the middle of the same century (Weinrich 1973, Bowler 1992). After evolutionary theory was achieved, even the complexity of the previous natural systems, proposed by the enlightened naturalist, could be understood as a foreshortening of a wider reality – the tree of evolution – in which time changes were not seen (*ibid*, Fig. V.1). Therefore the abduction of the system of nature by evolutionary theory was a long term process socially and historically supported by a broad endeavor –though the very moment of unveiling occurs in particular situations and subjects. However, more simple abduction occurs every day by perceiving the world around us.[54]

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52 It is here worth mentioning – for the sake of contrasting the Platonic tradition with our asserted open universe of messages – the case referred to by Eco and Peirce of Kepler's discovery of the ellipsoidal orbit of Mars. Kepler started moving within a Platonic terrain in which the movements of the planets were ideally attributed to Platonic bodies – as can be read in the *Mysterium cosmographicum*. However, when he started dealing with the overwhelming data of Tycho Brahe's observations, he applied his creative capacity to find the order that later on grounded Newton's mechanics – based upon those observations, but not being reducible to them (Rossi 1998).

53 That was, for instance, the case with Kepler's abduction of the orbit of Mars, with respect to previous models. The usage of combinations of circular movements, by means of the Ptolemaic – and Copernican – system of deferents and epicycles, gave up an error of eight minutes of arc with respect to Tycho Brahe's observations. This disqualification of the former model impelled Kepler's search (Rossi 1998).

54 Peirce – and generally the study of abduction – refers to this kind of daily abductive inferences (Douven 2011). The author has discussed elsewhere an example of perceptual

4.3 Moving into the understanding triangle

Relying on abduction, which adds something radically new to previous knowledge: induction comes to complete the validation of the achieved abduction with respect to the meaning-offer of natural messages (i.e. the effectiveness in giving an account of observed phenomena); and finally, deduction serves to facilitate interpretation of the natural messages (phenomena) that have been successfully abducted before and incorporated into the symbolic code of the observer, widely shared with and received from his community. In fact, language can be considered as a repertoire of abducted phenomena by a giving culture; and culture itself as a broader system of signs – integrating language, as one of its fundamental parts (Eco 1973).[55]

Hence, while deduction and induction seemed to be unable to come out of the isolation symbolized by Platonism and Funes' exhaustiveness in the triangle of understanding (Fig. 5), abduction enables that even these previously rejected inferential paths have a significant role in the general interpretation of natural messages. In communicational terms: through *abduction,* the observer incorporates new worldly codes (instead of otherworldly ones) for interpreting natural messages; through *deduction,* the codes, already possessed, are reliably arranged for decoding within the multifarious frames of received messages; through *induction*, the validity of the possessed codes is tested by confronting their interpretative ability with the enormous variability of received messages, thus enabling a feeling for the need of new abductions, that is, for better touching reality. In Fig. 6, the role played by each of these inferential processes is depicted within the understanding triangle, where also some extreme and dystopic positions are represented: the aforementioned Funes' perception, Plato's forms, Orwell's Newspeak (whose formal similarity with Plato's solution to the knowledge problem was argued in §1.2), and two others that bound the triangle on its upper sides. These correspond to extreme stances in which the research endeavor to grasp reality is only directed toward the extensiveness of either the object (in isolation) or the world (omitting internal features of the object). The former position, which can be ascribed to an extreme specialization of the sciences, has been symbolized by the "*learned ignoramus*", criticized by José Ortega y Gasset in the "Revolt of the masses" (1930):

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abduction in which the relation to induction is exhibited, showing the shift from one abducted percept to another (Díaz & Pérez-Montoro, 2011b).

55 Particularly when the related abduction brings about a significant change in one or more scientific disciplines – invalidating some core theories –, this process corresponds to the revolutionary changes, referred to by Thomas Kuhn (1996), whereas induction, deduction – as well as abductions concerning auxiliary hypothesis as considered by Popper, Lakatos or Laudan – constitute the kernel of "normal science".

> He is not learned, for he is formally ignorant of all that does not enter into his speciality; but neither is he ignorant, because he is "a scientist," and "knows" very well his own tiny portion of the universe. (p. 112)

The term "learned-ignoramus" seems in itself a phrase in Orwell's Newlanguage of the "*doublethink*" type, though its sense in Ortega's text as cited is completely meaningful. Indeed, a narrow parallelism to Ortega's critique can also be found in Orwell's short description of vocabulary C:

> "Any scientific worker or technician could find all the words he needed in the list devoted to his own speciality, but he seldom had more than a smattering of the words occurring in the other lists." (Orwell 1949, appx)

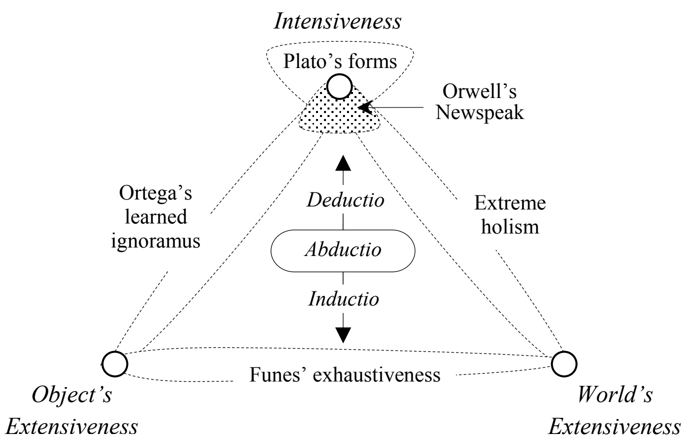

Figure 6: Understanding triangle in which some extreme (dystopic) positions are compared. Plato's viewpoint is represented by an inverted triangle in order to express its relation to otherworldly extensiveness, which is not the case with Orwell's Newspeak. The articulation of abduction-deduction-induction to move within the triangle is represented on its inside.

Though in Fig. 6, the "learned ignoramus" reaches from intensiveness to the object's extensiveness, Ortega's critique specifically points to the danger that, scientific knowledge – through extreme specialization – would approach "a stage where it can no longer continue its advance" (p. 114). But since advancing implies abductions, in the long-term this position would approach the case of Newspeak, in which the use of language tends to "duckspeaking", "spraying [automatically] forth the correct opinions" (Orwell, ibid).

The complementary of this learned ignorance corresponds to an *extreme holism,* in which reality is exclusively grasped with regard to the relations among things insofar as they belong to a whole; in other words, an extreme systems approach whose corresponding intensiveness is defined by functions and goals of the system, while its elements are formally reduced to relations between inputs and outputs.[56]

Similarly to how things become meaningless without the system of things to which they belong – outside the scope of the learned ignoramus –, systems also become meaningless and even lifeless in the long run without the possibility of being changed through the inherent possibilities of the integrating parts not manifested in the given relations of the current system.

In sum, the possibility of preserving openness, symbolized by the understanding triangle, implies embracing its three corners, whereas, if any of these is missing, the related situation drives toward a strict limitation of the universe of natural messages that is unable to cope with the evolving universe and the problems arising within it.

The inversion of Orwell's Newspeak and Plato's forms represented in Fig. 6 as two inverted triangles also corresponds to a symmetric stance with regard to the knower: while Plato attempts to attain the release of the captives in the cavern, turning them around; Orwell shows how some unbreakable chains can be provided to ensure the captive's stillness. In both cases, the subject is confined to a limited universe (bounded by a clear and unambiguous code) from which reality is out of reach.

Concluding Remark

The distinction stated between open and closed universes of messages – whatever the related closeness is among what has been referred to above – constitutes the keystone for distinguishing messages that can keep to some real mission (*officii*), thus with *angelía*, with respect to those whose mission diminishes beyond a given boundary and keep on traveling without mission or with some bastard one, thus *dysangelía*. The latter was the case with messages codified in Newspeak, by extreme holism, by learned ignorance, reported by Funes, or related to Platonic forms.

Focusing in contemporary societies, these are some of the questions we should pursue for knowing whether we are moving toward a "message society" or toward a "time of empty angels": Are we providing the conditions to move within the understanding triangle, or to confine us within its borders? Is our code-sharing flexible enough to accomplish the necessary creative

[56] This comprises of course not the broad and varied stances of system science – though some practitioners can be identified – and particularly not the viewpoint of complex systems science or second order cybernetics, which can be regarded as the endeavor to avoid extreme holisms (Díaz and Aguado 2010).

abductions? To what missions are the messages, currently disseminated, really commissioned? Are we multiplying the reflections of shadows or confronting reality as the lover does when (s)he intends to unveil the beloved? …

Oh mighty love! Man is one world, and hath
Another to attend him.

George Herbert (cit. Emerson 1836)

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