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Abstract *Recently, the methods of quantum theory, especially quantum information, started to be widely applied outside of physics: in cognitive, social sciences, economics, finance, decision making and biology. We propose a quantum-like model: the "information laser". The basic assumption is the discrete structure of state spaces related to the quantization of information. The information field acts in the form of indistinguishable quanta of "social energy" analog to photons. The massive flow acts as a pump. In this framework an information selection process by agents under constant pressure of massive repeated information leads to collective "resonance" effects in analogy with laser cavity and stimulated emission. In order to make operational parallels between physical lasers and the information laser we identify the essential features of laser operation. An application to the analysis of recent disruptive social events (color revolutions) is discussed.*

The formalism of quantum mechanics is now widely explored to describe biological, cognitive, psychological, and socio-political phenomena. This formalism provides the consistent probabilistic picture of observations performed for systems exhibiting (statistically) quantum-like features: from cells, animals, and humans to societies and ecosystems. In particular, in recent papers [1, 2] the model of *Stimulated Amplification of Social Actions* (*SASA*) was presented describing a kind of information laser device. It has to be outlined that at the very beginning of laser research, parallels have been made between laser behavior and other disciplines, considering the laser concept as a general principle with potential applications outside physics, for example in the *Synergetics* approach by H. Haken [3] where the focus was put on the laser phase transition and non-linear dynamics analogy and in the works on the laser statistical aspects by M. Lax [4].

On a more fundamental level the quantum features at the origin of laser action remain an open question. A full quantum analysis of a laser [5], leads to involved quantum diffusion Fokker-Planck equations using quantum operators. The concept of a laser has been evolving with the better understanding of laser physics. At the beginning a laser was understood as a source of an intense, sharp beam, but it was soon realized that the high intensity was not the only attribute of a laser, one must also consider its coherence, or photon statistics, that constitutes the most fundamental distinction of laser light from light of a usual lamp. The coherence of a laser is more specifically described by the first- and second-order correlation functions which are very popular in quantum optics. One of the important points of practical importance is to determine when a light emitting device has exceeded the so-called threshold and becomes a laser. Recently, an interesting discussion between H. M. Wiseman [6] and W. Elsäßer [7] highlighted an important point: a crucial property of laser light above threshold is that a laser must have stable intensity, more precisely that the intensity fluctuations become insignificant and only phase fluctuations contribute to the statistics of a laser beam.

A motivation of the approach presented here is to define the operational conditions of a laser using system parameters, not relying on specific laser technology, these parameters can then be extrapolated to domains outside physics. Beyond the well-known rate equations for atomic populations and photons, describing the internal mechanisms of a laser, quasi-classical models for the laser coherence characteristics can be used. A constant diffusion Fokker-Planck equation on the phase probability distribution permits to describe the different behaviors below and above threshold. A complete analysis for semiconductor laser using this approach was developed in [8], demonstrating laser coherence and phase transition behavior in agreement with experimental results.

The physical laser (ΦL) parameters permitting to give a faithful system description of laser behavior are: - the laser frequency ν of the photon in the two-level energy transition $E_2 - E_1 = h\nu$; - the output laser power P issued from the laser cavity related to the total photon number n; - the pump power rate R linked to inversion ΔN below threshold and to power P above; - the laser spectral width $\Delta\nu$, this last parameter relates the degree of coherence; - the laser cavity characterized by the photon lifetime T_p linked to cavity dimension L and reflection coefficient R; - the amplification bandwidth $\Delta\nu_g$. Internal parameters can be derived from these by well-known laser equations for example for the spontaneous emission time T_{sp}.

The concept of *information laser* (*IL*) consists of the following basic elements: - a quantum information field; - its excitations; - quanta of information; - gain medium; - agents. The additive energy transmitted by the information field is absorbed by the agents, it is the *social energy*. The agent gain medium emits and absorbs discrete portions of social energy so that agents belonging to the same social medium produce stimulated emission.

The information field contributing to the social energy can be associated with the photon number *n*, and is independent of the frequency. The *color* of the social energy is on the other hand represented by frequency and coherence and is induced by the filtering/selecting process by agents under constant pressure of massive continuous information, leading to resonance effects as in a laser cavity. The massive flow acts as a pump of indistinguishable information accumulating continuously, the result is *SASA*.

laser feature	**Physical Laser ΦL**	**Information Laser *IL***	**System parameter**	**Internal parameter**
pump	input pump power	exciting information field	R	ΔN , g
amplification	atomic gain	behavioral agent gain medium	$\Delta \nu_a$	g, T_{sp}
frequency	photon energy	social color	ν	E_2-E_1
mode	optical cavity	repetition/selection of information	T_p	L, r
power	optical power	rush of social energy	P	n
coherence	spectral linewidth	definiteness of social color	$\Delta \nu$	T_p, T_{sp}

Table 1: Parameters for Physical Laser and Information Laser.

An application can be sought for the analysis of new socio-political phenomena such as the so-called “color revolutions” which initiated in the territories of the former Soviet Union and in the Balkans. Recently similar features in western democratic systems originated from protests against government corrupted system. For example a group of excited humans imposed to the intensive flow of communications, say about corruption of the state leaders would emit quanta generating actions against corruption of state leaders - a coherent wave of anti-corruption protests. These phenomena are the subject of numerous studies and publications in political and social sciences (see [1, 2] for references). An adequate theory for these dramatic socio-political phenomena is still lacking. In this situation, it seems motivating to explore the correspondence and to define a methodology based on the laser formalism in order to explain the outburst of these phenomena.

This work has also the goal to identify the possible causes of instability in a complex environment leading therefore to prevention guidelines for decision making. One of the most striking features of SASA is *indistinguishability* which is a central methodological issue of application of the mathematical formalism of quantum theory to social science.

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events in social dynamics: color revolutions

Socio-political phenomena called "**color revolutions**" were initiated in territories of the former Soviet Union, the Balkans and middle east. Humans under intensive flow of media communications emit quanta generating a coherent wave of anti-corruption protests.

Object of numerous studies and publications (see [1,2] for references) these events lack adequate theory.

information laser : a "quantum like" approach

Quantum mathematical formalism applied outside of physics for cognitive-social sciences, economics and biology to model context-sensitive systems: it is the **quantum-like paradigm** (Khrennikov)

An **information laser** [1] is based on the quantization of information describing **Stimulated Amplification of Social Actions (SASA)** [2] characterized by **indistinguishability**, a central issue of the application of quantum theory to social science.

The **fractaquantum** [3] hypothesis applies to all indivisible scales in nature, regardless of their size. It addresses the incompatibility of quantum indistinguishability with macroscopic structures.

information laser parameters

The additive energy transmitted by the information field is absorbed by the social agents, it is the **social energy**.

This massive flow acts as a **pump of indistinguishable information** accumulating continuously, the result is SASA.

The gain medium emits and absorbs discrete social energy, agents belonging to the same social medium produce stimulated emission.

	Physical	SASA
pump	feed power for inversion	massive flow of information
cavity	optical cavity resonator	repetition /selection of quanta of information
active medium	2 energy level system	receptive individual agents
field quanta	coherent photons	selected indistiguishable color information

system approach for physical and information laser

Laser concept as a **general system principle** already in **Synergetics** (H. Haken [4]) and in statistical approach (M. Lax [5]).

A motivation here is to define a laser using **system parameters**, not relying on specific technology. Some laser properties are universal.

	physical laser	information Laser	system	Intern.
pump	input pump power	exciting information field	R	ΔN , g
amplification	atomic gain	behavioral agent gain medium	$\Delta\nu g$	g, T_{sp}
frequency	photon energy	social color	n	$E_2 - E_1$
mode	optical cavity	repetition/selection of information	T_p	L, r
power	optical power	rush of social energy	P	n
coherence	spectral linewidth	definiteness of social color	$\Delta\nu$	T_p, T_{sp}

information laser and coherence: the social color

Each class of information communications is characterized by its social energy: $E_s = n\,h\nu = n(E_2 - E_1)$ carried by n agents.

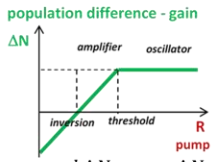
Coherence corresponds to **social color** (mode u) generating a **coherent beam of social actions** (*e.g.* anti-globalism protests).

People in the excited state receiving quanta of information of the same social color emit information quanta with the same social color.

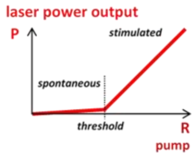
operational conditions of a system laser

A **two rate-equation model** can be used. Parameters are: pump power R, light output power P (proportional to the photon number n) and the inversion of the gain medium ΔN, proportional to the population difference $N_2 - N_1$.

This simple nonlinear model shows the **laser phase transition**.



$$\frac{d\,\Delta N}{dt} = R - \frac{\Delta N}{T_{sp}}$$

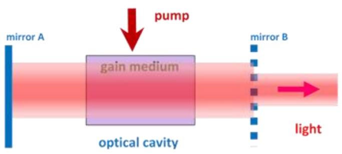


$$\frac{dP}{dt} = P\,g\,\Delta N - \frac{P}{T_p}$$

filtering and resonance: the social cavity

The atomic transition defines the two-level system energy difference but the stabilizing character is brought in by the cavity.

The color of the social energy is induced by the **filtering/selecting process** by social agents under constant pressure of massive continuous information, leading to **resonance** as in a laser cavity.



quantum origin of laser behavior: an open debate

The laser is characterized by a n-photon u-color quantum state :

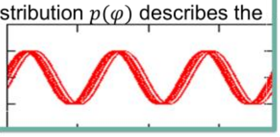
$$|\Psi> = |n, u>$$

A rigorous quantum description of laser behavior, is given by a Fokker-Planck (FP) model using quantum operators [6].

Important question: when does a light emitting device becomes a laser ? Discussions in [7,8] highlighted that only phase contributes to the statistics of a laser beam.

A FP equation on the phase probability distribution $p(\varphi)$ describes the coherence throughout laser threshold [9]:

$$\frac{dp(\varphi)}{dt} = \frac{\Delta\nu}{2}\frac{d^2p(\varphi)}{d\varphi^2}$$



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