# LCPD 2013

# From Linked Data to Concept Networks

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Motivation Concept network Example Benefits LYR platform • Future work

### **Citations have no precise meaning**

#### PHYSICAL REVIEW A

VOLUME 59, NUMBER 3

#### Time-of-arrival states J. Oppenheim,<sup>1,\*</sup> B. Remik,<sup>2,†</sup> and W. G. Unruh<sup>3,‡</sup>

<sup>1</sup>Department of Physics **10**, Americany, Beneticy Of Beslin Colombia, GSA Apricultural Road, Tencource & Philia Colambia, Candro 1977(21) <sup>1</sup>Devortinal Davision, **7**:4, ISS 2088, Let Alamon Katone Robert DirIZI <sup>1</sup>Call Growing and Consultage Payners, Department of Physica and Astronomom, University of Patistic Academia, 6224 Apricalulua Davis, Fancource, Brittin Colambia, Canada 1977[21] (Beniroweil T July 1990).

Although one can show formally that a time-d-servicel speaker cannot exist, one can modify the low-momentum behavior of the common kindle of the liss self-adjoint. We show that such a modification results in the difficulty that the eigenstates are detained partners. In an eigenstate of the modified time-of-aerival operator, the particle, at the predicted time of arrival, is found for avoid time of arrival, with probability 1/2. (Bioto-SatViO)90140-014

PACS number(s): 03.65.-w

#### I. INTRODUCTION

In quantum machanics, observables ika position and momatum are approximately logeneous related that the first state of the over, then is no operator associated with the time it takes for a particle to arrive to a final clotical. Call can construct not a time-determint operator (11), but in physical massing is amphenon [2-41]. It is build machanics, no can surve the hypothese states and the state of the states of the location of the states and the states are particle states in the location of the set on state theory on the state of the states of the operator implies the actions of a time operator if the Humiltanian is bound have a time operator if the Humiltanian to home the statement of the states of the states. Then it is a particle with the existence of a time-operator if the Humiltanian of the system is bounded from shows or below.

"There has, forware, been meaned interest in do time of arrial, following the suggestion by Gerc Rowll, and Testhat can modify the time-of-mirried operator in such arrays at to mike a bird-fightin [16]. The data is that by modifying the operator in a two-fight many start of the second operator which behaves in much the same way as the unmodified time-of-mirried commutations.

modified imm-of-strivel operator. In this paper, we examine the behavior of the modified time-of-arrival algorizates, and show that the modification, no matter how small, radically effect the behavior of the states. We find that the particle in these signatures do not marrie with a probability of 1/2 at the predicted times of arrival.

rical. In Soc. II we show why the time-of-arrival operator is not self-adjoint, and explore the possible modifications that can be made in order to make it self-adjoint. We then explore some of the properties of the modified inter-of-prival states. In Soc. III we examine normalizable states which are other at respersions of time of arrival eigenstates, and discuss

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the possibility of localizing these states at the location of arrival at the time-of-mirital low results for the "immodfield" part of the inter-of-mirital states are a space with the state independently [7]. Our control result is continued in soc. IV where we show that in an eigenment of the modified time-of-mirital speakers, the predicts at the predicted time of arrival, it found have burn the arrange on [7] at the array of the state of the state of the modified time of array of the state of the state of the modified time of a state of the state of the state of the state of the modified time of the state  $\mathcal{J}_{ij}$  is the strengt kinetic energy of the particle. We and with containing remarks in Sec. V.

MARCH 1999

#### IL TIME-OF-ARRIVAL OPERATOR

From the correspondence principal, the time-of-arrival operator to the point x=0 can be written formally in the k representation as

 $\mathbf{T}(k) = -im \frac{1}{\sqrt{k}} \frac{d}{dk} \frac{1}{\sqrt{k}} = -im \left( \frac{1}{k} \frac{d}{dk} + \frac{d}{dk} \frac{1}{k} \right), \quad (1)$ 

where  $\sqrt{k}\!=\!i\sqrt{|k|}$  for  $k\!<\!0.$  A set of eigenstates for this operator is given by

 $g_{r_{A}}(k) = \alpha(k) \frac{1}{\sqrt{2\pi m}} \sqrt{k} e^{i \pi_{A} k^{2} \partial_{a} m},$  (2)

where  $\alpha = \theta(k) + i \theta(-k)$ . However, the operator is not selfadjoint and these eigenstates are not orthogonal:

 $\langle t'_{A}|t_{A}\rangle = \frac{1}{2\pi m} \int_{0}^{\infty} dk^{2} e^{(ik^{2}/2m)(t_{A}-t'_{A})}$ 

$$= \delta(t_A - t'_A) - \frac{t}{\pi(t_A - t'_A)}.$$

It is important to recall that a symmetric operator which is not self-adjoint always has complex eigenvalues and eigen-

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(4)

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(6)

#### Time Eigenvectors and Their Applications<sup>\*</sup>

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(Received 16 September 1991)

Time eigenvectors and time operator are constructed from energy eigenvectors of system. Some features of them are described. Their applications to harmonic oscillating system and to double wave description of system are discussed. PACS: 01.65 Ca

Time eigenvectors are as quite useful in physics as energy eigenvectors are. Sitter time and energy are a pair of canonically conjugate quantities, we expect that the relation between time and energy eigenvectors is similar to that between position and momentum eigenvectors for a particle. In this letter, we construct time eigenvectors from energy eigenvectors as a system. Then we write down time operator from time eigenvectors and examine their features. Finally, we discuss the applications of time eigenvectors in harmonic scellators and to downle wave description of system.

First we consider a system having continuous energy spectrum. Let  $|E\rangle$  be the eigenvectors of energy satisfying

 $\hat{H}|E\rangle = E|E\rangle$  ,  $E \in (-\infty, +\infty)$  ,

$$\langle E'|E \rangle = \delta(E' - E)$$
,  $\int_{-\infty}^{+\infty} dE|E \rangle \langle E| = \hat{1}$ . (1)

We construct a new vector set  $\{|t'\rangle\}$  from set  $\{|E\rangle\}$ :

$$|t'\rangle = \frac{1}{\sqrt{2\pi\hbar}} \int_{-\infty}^{+\infty} dE |E\rangle e^{-\frac{i}{\hbar}Et'}$$
, (2)

it satisfies  $\langle t'|t''\rangle = \delta(t' - t''), \quad \int_{-\infty}^{+\infty} dt|t\rangle\langle t| = \hat{1}.$  (3)

Defining operator  $\hat{t} = \int_{-\infty}^{+\infty} dt \, t |t\rangle \langle t|$ ,

f-∞

 $\hat{t}|t'\rangle = t'|t'\rangle$ .

It is easy to get the following results:  $\langle E'|\hat{l}|\psi \rangle = \int_{-\infty}^{+\infty} dt \int_{-\infty}^{+\infty} dE t \langle E'|t \rangle \langle t|E \rangle \langle E|\psi \rangle = i\hbar \frac{\partial}{\partial E'} \langle E'|\psi \rangle$ ,

\*Supported by the National Natural Science Foundation of China.



PRA 59 1804

cites



## **Citations have no precise meaning**

#### There are many reasons why authors cite the work of others\*:

- 1 Paying homage to pioneers.
- 2 Giving credit for related work.
- 3 Identifying methodology, equipment, etc.
- 4 Providing background reading.
- 5 Correcting one's own work.
- 6 Correcting the work of others.
- 7 Criticising the work of others.
- 8 Substantiating claims.
- 9 Alerting researchers to forthcoming work.
- 10 Providing leads to poorly disseminated, poorly indexed, or uncited work.
- 11 Authenticating data and classes of fact-physical constants, etc.
- 12 Identifying original publications in which an idea or concept was discussed.
- 13 Identifying the original publication describing an eponymic concept or term such as, e.g. Hodgkin's disease ...
- 14 Disclaiming work or ideas of others.
- 15 Disputing priority claims of others.

#### **Citation network**

struct an operator which is conjugate to the Hamiltonian if H is bounded from above or below [3].

One might try to modify **T** in order to make it self-adjoint [6] Consider the operator

$$\mathbf{T}_{\epsilon}(k) = -im\sqrt{f_{\epsilon}(k)}\frac{d}{dk}\sqrt{f_{\epsilon}(k)}, \qquad (5)$$

where  $f_{\epsilon}(k)$  is some smooth function which differs from 1/konly near k=0. Since u(k) and v(k) could diverge at the origin at a rate approaching  $1/\sqrt{k}$  and still remain square integrable, if  $f_{\epsilon}(k)$  goes to zero at least as fast as k, then  $T_{\epsilon}$ will be self-adjoint and defined over all square-integrable functions. However, as we show in Sec. IV, these eigenstates do not behave as one would expect a time-of-arrival eigenstate to behave.

It can be verified that  $\mathbf{T}_{\epsilon}$  has a degenerate set of eigenstates  $|t_A, +\rangle$  for k>0 and  $|t_A, -\rangle$  for k<0, given by

 $g_{t}^{\pm}(k) = \langle k | t_{A}, \pm \rangle$ 

the  $t_A = 0$  state, (8) can be integrated to give

$$_{\epsilon}\tilde{g}^{+}(x)_{t_{A}} = \frac{\epsilon}{\sqrt{2xim}} \Phi(\sqrt{i\epsilon x}),$$
 (9)

where  $\Phi$  is the probability integral. For large x,  ${}_{\epsilon}\widetilde{g}^{+}(x)_{t_{A}}$ goes as  $1/\sqrt{x}$  and the quantity  $\int dx' |_{\epsilon}\widetilde{g}_{t_{A}}^{+}(x')|^{2} \sim \ln x$  diverges as  $x \to \infty$ . For small x,  ${}_{\epsilon}\widetilde{g}_{t_{A}}^{+}(x)$  is proportional to  $e^{-i\epsilon x}$ . Its modulus squared vanishes when integrated around a small neighborhood of x = 0.  ${}_{\epsilon}\widetilde{g}^{+}(x)_{t_{A}}$ , then, is not localized around the point of arrival, at the time of arrival. This will also be verified in Sec. III where we examine normalizable states. Although  ${}_{\epsilon}\widetilde{g}^{+}(x)_{t_{A}}$  is not localized around the point of arrival, one might hope that this part of the state does not contribute significantly in time-of-arrival measurements when  $\epsilon \to 0$ . However, we will see that for coherent superpositions of these eigenstates. half the

Our aim is to specify such citations more precisely and to represent them in machine-processable way.

#### Towards concept network

#### **URI** assignment

For instance, we may choose

$$f_{\epsilon}(k) = \begin{cases} \frac{1}{k} \text{ for } |k| > \epsilon \\ \epsilon^{-2}k \text{ for } |k| < \epsilon. \end{cases}$$
(36)

Using this, we define the regulated time-of-arrival operator as

$$\hat{T}_{\epsilon} = -i\frac{m}{\hbar}\sqrt{f_{\epsilon}(k)}\frac{d}{dk}\sqrt{f_{\epsilon}(k)}, \qquad (37)$$

to be compared with the unregulated operator (27). Notice that on any state with support on  $|k| > \epsilon$  the operators  $\hat{T}_{\epsilon}$  and  $\hat{T}$  are equal. Their action differs only on the component of a state with arbitrary low momentum. As we shall see, the probability distribution for the time of arrival  $\pi(T)$  com-

#### http://link.aps.org/doi/10.1103/ PhysRevA.54.4676**#37**

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 $g_{t}^{\pm}(k) = \langle k | t_{A}, \pm \rangle$ 

http://link.aps.org/doi/10.1103/ PhysRevA.59.1804**#5** 

#### **Towards concept network**

Using terms from ontologies we can name the relation between the two concepts e.g.



In this case we simply identify the two concepts.

#### **Towards concept network**

We also want to define more precisely (using terms from ontologies) the relationship between each article and the concepts discussed (considered etc.) in it e.g.



#### **Concept network**

In this way we obtain a network which we call a concept network.



A concept network can be represented as linked data.

#### **Concept network and citation network**



#### Concept network – an example

In our example we use the following ontologies:

SACO (Scientific Article Content Ontology) - an ontology containing a set of object properties enabling description of what is done/used in a research publication.

In such publication something (e.g. some element of the theory, entity, resource) is *analyzed, described* etc.

#### Concept network – an example

**PHYSO** (Physical Sciences Ontology) - an ontology describing main concepts (e.g. *principle, problem, assumption*) and relations (e.g. has property, consequence of) of physical sciences.

# qu<mark>ONTO</mark>m

**quONTOm** – an ontology describing main concepts (e.g. *observable, Hamiltonian*) and relations (e.g. *commutator, orthogonality*) of *quantum mechanics*.

Remark: these ontologies are at the moment incomplete and are gradually developed towards more complete forms.

#### Concept network – an example



- 7. http://arxiv.org/abs/quant-ph/9611015
- 8. http://pra.aps.org/abstract/PRA/v61/i2/e022118
- 9. http://link.aps.org/doi/10.1103/PhysRevA.59.1804 10.http://arxiv.org/abs/quant-ph/0102005

\*labels are omitted for simplicity

#### **Benefits**

 Scientific articles are no longer only humanreadable data islands

 They become machine-understandable (at least in some parts)

 There are precise (machine-understandable) relationships between articles (and concepts considered in them)

Machines are able to process relationships between articles and concepts

Automatic creation of valuable and precise concept networks seems to be very difficult.

However, one can imagine manual creation by authors and research community with the help of special tools.

LYR (Link Your Research) is a web platform supporting creation of concept networks (RDF links) for scientific articles\*.

\*Additional information can be found online at http://www.linkyourresearch.org



WARNING: Please keep in mind that presently this is an **experimental service** only and as such is available for testing and evaluation. It might be inaccessible, broken or flawed without any notice. We take no responsibility for the reliability of the service or the data. Please contact us if any problem occurs or if you have any suggestions and comments.



The process of adding new links has a few steps and consists of filling in a form available on the website. Knowlegde of an RDF syntax is not required.



All links generated using the LYR tool are stored in RDF Triple Store. The LYR tool enables an easy search and exploration of the dataset.

http://link.aps.org/doi/10.1103/PhysRevA.59.1804#5	search
resource URI	
•  type	
http://merlin.phys.uni.lodz.pl/quONTOm/SelfAdjointOperator self-adjoint operator	resource type
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http://merlin.phys.uni.lodz.pl/quONTOm/SelfAdjointOperator	
http://link.aps.org/doi/10.1103/PhysRevA.54.4676#37_self-adjoint operator	
http://link.aps.org/doi/10.1103/PhysRevA.54.4676	es linked with
http://link.aps.org/doi/10.1103/PhysRevA.59.1804 http://link.aps.org/doi/10.1103/PhysRevA.59.1804#6_eigenstates the	resource
resources of t	ne same type

#### Searching for some term:



It is possible to retrieve links forming concept networks using SPARQL queries.

#### SPARQL

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/TR/rdf-schema/#>
```

```
SELECT DISTINCT * WHERE
    { GRAPH ?article { ?concept ?relatedBy ?toSpecifier . }} LIMIT 100
```





 General hints on how to create concept networks for publications in various disciplines

Further development of LYR platform

Development and harmonization of used ontologies

#### Future

Perhaps one day, in addition to putting references in scientific publications, authors will create concept networks.

That will bring us closer to the semantic science.