2016-10-01.11:09 Sat

From Steve Schnetzer's (Rutgers) Lec03_SU(2) presentation of U(1) group:

The $U(1)$ Group

The set of all functions $U(\theta) = e^{i\theta}$ form a group.

$$E(\theta)\cdot U(\theta') = e^{i(\theta+\theta')} = E(\theta+\theta')$$
$$I = E(0)$$
$$E^{-1}(\theta) = E(-\theta)$$
$$\big(E(\theta_1)\cdot E(\theta_2)\big)\cdot U(\theta_3) = E(\theta_1)\cdot\big(E(\theta_2)\cdot E(\theta_3)\big)$$

This is the one dimensional unitary group

$$U(1)$$

This is just the frequency set $e^{i\omega\mu}$, $\omega \text{ fixed} \in \boldsymbol{R}$, where ω is the "frequency factor" in radians and μ is a linear dimension (length axis) along which the outcome of the frequency function is applied.

Math notations are kind of sloppy about the order and context of parameter substitution. What's really going on here is:

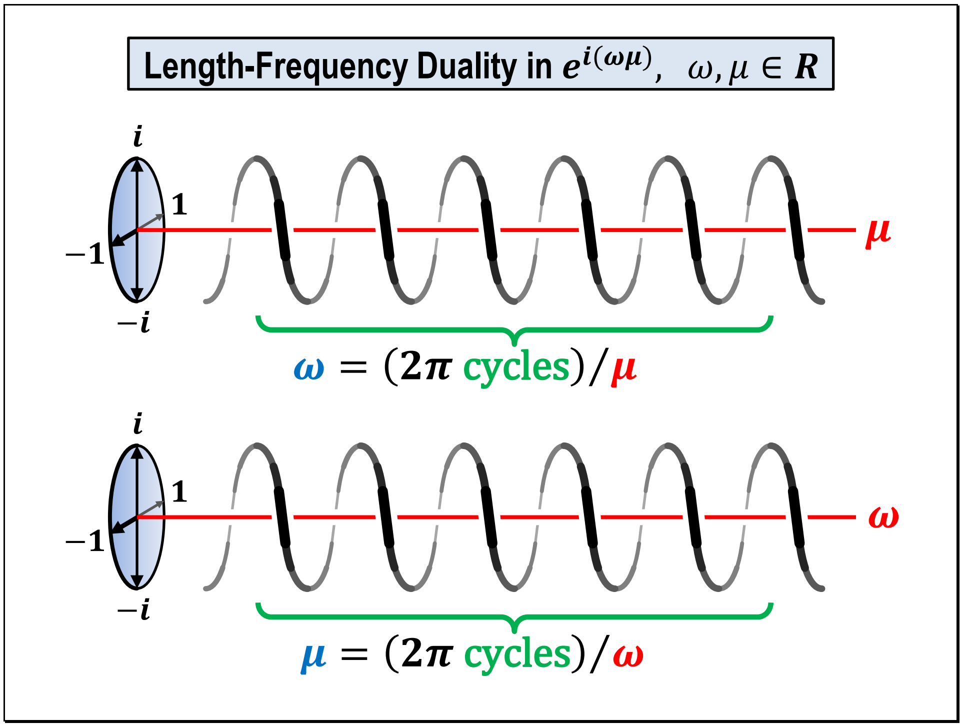
$$\begin{array}{c} e^{i\xi} \mid \xi \in \boldsymbol{R} \\ \xi = \omega\nu \mid \omega,\mu \in \boldsymbol{R} \\ \text{So:} \\ e^{i\omega\mu} \mid \omega,\mu \in \boldsymbol{R} \end{array} \quad (1)$$

That is, starting implicitly with Euler's equation $e^{ix} = \cos x + i\sin x$, then x $(= \xi)$ is factored into two $\boldsymbol{R}$ numbers ω and μ. The meaning of the two factors is then varied by the reader's interpretation of them.

Specifically, one of $\{\omega, \xi\}$ is interpreted as a *linear axis*, and the other as a *frequency*. The Fourier duality of this interpretation approach is immediately apparent, since either factor can quite arbitrarily be interpreted as the linear axis or as the frequency. The differences are externally by the information context of the classical observer, rather than being inherent in either of the factors. This duality can be expressed geometrically by

$$\begin{array}{ccc} e^{i\omega} & \equiv & e^{i\omega(\mu\forall\in(-\infty,+\infty))} \\ e^{i\mu} & \equiv & e^{i\mu(\omega\forall\in(-\infty,+\infty))} \end{array} \quad (2)$$

That is, as long as it is understood that there is an implied linear parameter in such expressions, the cofactor of i can be understood as a frequency. By displaying the complex plane as ortha to the linear axis, the result is a 3D display in which the hidden factor μ or ω becomes the linear axis, usually represented by x, and the visible i cofactor ω or μ is interpreted as the frequency.



Note that Fourier duality is inherent in this definition, since μ could just as easily be interpreted as frequency and ω as length. As the frequency $\omega \to \pm\infty$, the helix becomes tighter.

What I'm not sure of is whether Schnetzer's slides are interpreting the θ parameter as $\xi = \omega\mu$, or as ω with a cofactor μ that is a fully elaborated linear axis. I suspect $\theta = \xi$, since the interpretation of ξ as a helical wave on a linear axis is human imposed. I'm not sure what the more "fundamental," pre-Fourier-duality interpretation of $e^{i\xi}$ is. Hmm.

End 2016-10-01.23:37 Sat

2016-10-02.22:02 Sun

Test of new "ts" timestamp paragraph, and "%ts" autoreplace text to insert new time in sortable format. Above is an example. Below is another test.

So:

1. Create a new empty paragraph (hit Enter),
2. Shift-Ctrl-s, ts, Enter,
3. %ts, Enter,
4. Up-arrow to put cursor in date filed, Shift-Ctrl-F9
5. Down-arrow, ready to start typing

2016-10-02.22:14 Sun

Seems to be working OK. The Shift-Ctrl-F9 converts the field over to text so that F9 updates on the document don't damage dates.

2016-10-02.22:17 Sun

"The limit is the illusion, the calculation is the reality." That is, for example, for expressions such as $e^{i\theta}$, which is a precise limit expressed in terms of the infinitely approachable but never fully reached limit e, the Taylor serious captures the reality of the underlying physics better than does the precise limit e of that series.

For $U(1)$, the focus seems to be on frequencies? That is, since the group is defined in terms of operations such as, $e^{\theta_1} \cdot e^{\theta_2} = e^{\theta_1+\theta_2}$ the emphasis seems to be on a fixed assumed linear point such as 1 at which various frequencies are added.

2016-10-02.22:55 Sun]

2016-10-03.~10:00 Mon (lost exact time to auto-update) [

Lie Groups

If the elements of a group are differentiable with respect to their parameters, the group is a Lie group.

$U(1)$ is a Lie group.

$$\frac{\mathrm{d}E}{\mathrm{d}\theta} = iE$$

For a Lie group, any element can be written in the form

$$E(\theta_1, \theta_2, \cdots, \theta_n) = \exp\left(\sum_{i=1}^{n} i\theta_i F_i\right)$$

The quantities F_i are the generators of the group.

The quatities θ_i are the parameters of the group. They are a set of i real numbers that are needed to specify a particular element of the group.

Note that the number of generators and parameters are the same. There is one generator for each parameter.

The group $U(1)$ is the set of all one dimensional, complex unitary matrices.

The group has one generator $F = 1$, and one parameter, θ.

It simply produces a complex phase change.

$$E(\theta) = e^{-i\theta F} = e^{-i\theta}$$

(You know, I'm still not 100% sure if the i in $i\theta$ in the summation on the left abobe is the index i or $\sqrt{-1}$. But surely it's the latter, since it makes absolutely no sense mathemtatically to multiply individual generators by the index values $1,2,3,\ldots$ One of the uglier examples of the notational overloading of i in any case. Maybe this fellow is not such a great source for a group theory overview after all…)

OK, so *generators* seem to be a fancy complex-matrix way of saying "unit vectors for orthogonal axes", and *parameters* seems to be the particular type of ordered quantity (not necessarily just $\boldsymbol{R}$) used to express a location along the axis implied by that unit vector. My premise I guess is still that matrix theory, darn Born and his sincere, in-your-face glorification of obscurantism, really is too complex for what it is trying to represent, and that in combination with group theory it has obscured much simpler relationships that could have been (can still be) expressed in simpler, more easily understood forms – the "thank goodness Mendeleev didn't know any group theory" theorem. Chemistry would likely still be wallowing around in weird little mathematical "symmetry relations" instead of more pragmatic modeling that pops out lesser symmetries if he had known and loved group theory.

A good example is the following definition of the quaternion unit vector set $\{\mathbf{1}, \boldsymbol{i}, \boldsymbol{j}, \boldsymbol{k}\}$ in terms of 2x2 complex matrices:

Let $\mathbf{1}$, $\mathbf{i}$, $\mathbf{j}$, and $\mathbf{k}$ be the following matrices:

$$\mathbf{1} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \qquad \mathbf{i} = \begin{pmatrix} i & 0 \\ 0 & -i \end{pmatrix}$$
$$\mathbf{j} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \qquad \mathbf{k} = \begin{pmatrix} 0 & i \\ i & 0 \end{pmatrix}.$$

Consider the set $\mathbb{H}$ of all matrices of the form

$$a\mathbf{1} + b\mathbf{i} + c\mathbf{j} + d\mathbf{k},$$

(Source: UPenn Jean Gallier's CIS 610 course materials,
page 5 of http://www.cis.upenn.edu/~cis610/cis610sl7.pdf*)*

There is absolutely nothing wrong mathematically with the above definition! It is in fact a useful way of enabling matrix-form calculation of $\boldsymbol{H}$ operations. But *dang it*, such a definition is just so incredibly biased towards $\{i\}$ of $\boldsymbol{C}$ as somehow being more "fundamental" than $\{i, j, k\}$ of $\boldsymbol{H}$! And even more annoying, the use of the matrix form utterly destroys the beautiful and deeply fundamental symmetry of the $\{i, j, k\}$ by converting it into three very ugly, highly asymmetric, and completely non-intuitive 2x2 matrices. There has to be a better way!

E.g., using my matrix multiplication format of $AB = C \;\Rightarrow\; \begin{array}{cc} & B \\ A & C \end{array}$ gives:

$$\begin{array}{cc} & j \\ i & k \end{array} \quad = \quad \begin{array}{cc} & \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \\ \begin{pmatrix} i & 0 \\ 0 & -i \end{pmatrix} & \begin{pmatrix} 0 & i \\ i & 0 \end{pmatrix} \end{array}$$

So sure, the ugly little i and j matrices perform perfectly correctly to give the ugly little k matrix, but it all feels so… wrong, at least in terms of added noise and visual confusion. The real rule is much, much simpler than the complexity that the matrix version implies. All that said, the matrix forms are very powerful for Lie algebras and for calculation, so once set up it makes a lot less difference whether you understand them well or not. They give accurate results, and the abstract forms are coherent and clean. My objection, such as it is, is the obscuration of insight into e.g. connections between forms that are represented separately within the SM (= Standard Model).

So a question: What is some cleaner form?

I should note that my own "balanced mobile" approach (diamond-plate form) of using only matrices with one 1 in every column and every row, balanced like a mobile, to represent not just $\{1, -1, i, -i, \dots\}$ but other "odd" roots of -1 also quickly gave highly asymmetric definitions of higher roots and of $\{i, j, k\}$ very quickly gave similarly asymmetric forms. So can I really complain about the standard equivalents?

1x1 $\quad \underset{1}{\begin{pmatrix}1\end{pmatrix}}$

2x2 $\quad \underset{1}{\begin{pmatrix}1 & \\ & 1\end{pmatrix}} \qquad \underset{-1}{\begin{pmatrix} & 1 \\ 1 & \end{pmatrix}}$

$$\text{4x4}\quad \underset{\underset{1}{\left\langle\begin{smallmatrix}|\\|\end{smallmatrix}\right\rangle}}{\begin{pmatrix}1&&&\\&1&&\\&&1&\\&&&1\end{pmatrix}} \underset{\left\langle\begin{smallmatrix}|\\-\end{smallmatrix}\right\rangle}{\begin{pmatrix}1&&&\\&1&&\\&&&1\\&&1&\end{pmatrix}} \underset{\left\langle\begin{smallmatrix}-\\|\end{smallmatrix}\right\rangle}{\begin{pmatrix}&1&&\\1&&&\\&&1&\\&&&1\end{pmatrix}} \underset{\underset{-1}{\left\langle\begin{smallmatrix}-\\-\end{smallmatrix}\right\rangle}}{\begin{pmatrix}&1&&\\1&&&\\&&&1\\&&1&\end{pmatrix}}$$

$$\text{4x4}\quad \underset{\langle -- \rangle}{\begin{pmatrix}&&&1\\&&1&\\&1&&\\1&&&\end{pmatrix}} \underset{\underset{i}{\langle -| \rangle}}{\begin{pmatrix}&&1&\\&&&1\\&1&&\\1&&&\end{pmatrix}} \underset{\underset{-i}{\langle |- \rangle}}{\begin{pmatrix}&&&1\\&&1&\\1&&&\\&1&&\end{pmatrix}} \underset{\langle || \rangle}{\begin{pmatrix}&&1&\\&&&1\\1&&&\\&1&&\end{pmatrix}}$$

I have a whole terminology for the $-45°$ diamond-plate forms, such as (I think) "pole", "candle, "tee", "stack", "sleep", something, something, "wake". I should find that volume…

$$\begin{matrix} & \begin{pmatrix}&&1&\\&&&1\\&1&&\\1&&&\end{pmatrix} \\ \begin{pmatrix}&&1&\\&&&1\\&1&&\\1&&&\end{pmatrix} & \begin{pmatrix}&1&&\\1&&&\\&&&1\\&&1&\end{pmatrix}\end{matrix}$$

2016-10-03.~23:00 Mon (lost exact time to auto-update)]

2016-10-04.~10:00 Tue (lost exact time to auto-update) [

Griffiths introduces the Gell-Mann "A-matrices," which are to SU(3) what the Pauli spin matrices are to SU(2):

$$
\begin{aligned}
\lambda^1 &= \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} & \lambda^5 &= \begin{pmatrix} 0 & 0 & -i \\ 0 & 0 & 0 \\ i & 0 & 0 \end{pmatrix} \\
\lambda^2 &= \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} & \lambda^6 &= \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix} \\
\lambda^3 &= \begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{pmatrix} & \lambda^7 &= \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & -i \\ 0 & i & 0 \end{pmatrix} \\
\lambda^4 &= \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \end{pmatrix} & \lambda^8 &= \frac{1}{\sqrt{3}}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -2 \end{pmatrix}
\end{aligned}
\qquad (9.9)
$$

$$\begin{bmatrix} & & & 0 & 1 & 0 \\ & & & 1 & 0 & 0 \\ & & & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \begin{bmatrix} & & & 0 & 0 & -i \\ & & & 0 & 0 & 0 \\ & & & i & 0 & 0 \\ 0 & 0 & -i & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ i & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} & & & 0 & -i & 0 \\ & & & i & 0 & 0 \\ & & & 0 & 0 & 0 \\ 0 & -i & 0 & 1 & 0 & 0 \\ i & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \begin{bmatrix} & & & 0 & 0 & 0 \\ & & & 0 & 0 & 1 \\ & & & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Squaring:

$$\begin{bmatrix} & & & 1 & 0 & 0 \\ & & & 0 & -1 & 0 \\ & & & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & -1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \begin{bmatrix} & & & 0 & 0 & 0 \\ & & & 0 & 0 & -i \\ & & & 0 & i & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -i & 0 & 1 & 0 \\ 0 & i & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} & & & 0 & 0 & 1 \\ & & & 0 & 0 & 0 \\ & & & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} & & & \frac{1}{\sqrt{3}} & 0 & 0 \\ & & & 0 & \frac{1}{\sqrt{3}} & 0 \\ & & & 0 & 0 & \frac{-2}{\sqrt{3}} \\ \frac{1}{\sqrt{3}} & 0 & 0 & \frac{1}{3} & 0 & 0 \\ 0 & \frac{1}{\sqrt{3}} & 0 & 0 & \frac{1}{3} & 0 \\ 0 & 0 & \frac{-2}{\sqrt{3}} & 0 & 0 & \frac{4}{3} \end{bmatrix}$$

So the squares are:

$$(\lambda^1)^2 = \begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{matrix} \qquad (\lambda^5)^2 = \begin{matrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{matrix}$$

$$(\lambda^2)^2 = \begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{matrix} \qquad (\lambda^6)^2 = \begin{matrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{matrix}$$

$$(\lambda^3)^2 = \begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{matrix} \qquad (\lambda^7)^2 = \begin{matrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{matrix}$$

$$(\lambda^4)^2 = \begin{matrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{matrix} \qquad (\lambda^8)^2 = \begin{matrix} \frac{1}{3} & 0 & 0 \\ 0 & \frac{1}{3} & 0 \\ 0 & 0 & \frac{4}{3} \end{matrix}$$

So: the common thread is that all of the squares have a trace of 2, with all trace components positive. Trying cross products of λ^1:

$$\begin{bmatrix} & \begin{pmatrix}0&1&0\\1&0&0\\0&0&0\end{pmatrix} \\ \begin{pmatrix}0&1&0\\1&0&0\\0&0&0\end{pmatrix} & \begin{pmatrix}1&0&0\\0&1&0\\0&0&0\end{pmatrix}\end{bmatrix} \quad \begin{bmatrix} & \begin{pmatrix}0&0&-i\\0&0&0\\i&0&0\end{pmatrix} \\ \begin{pmatrix}0&1&0\\1&0&0\\0&0&0\end{pmatrix} & \begin{pmatrix}0&0&0\\0&0&-i\\0&0&0\end{pmatrix}\end{bmatrix}$$

$$\begin{bmatrix} & \begin{pmatrix}0&-i&0\\i&0&0\\0&0&0\end{pmatrix} \\ \begin{pmatrix}0&1&0\\1&0&0\\0&0&0\end{pmatrix} & \begin{pmatrix}i&0&0\\0&-i&0\\0&0&0\end{pmatrix}\end{bmatrix} \quad \begin{bmatrix} & \begin{pmatrix}0&0&0\\0&0&1\\0&1&0\end{pmatrix} \\ \begin{pmatrix}0&1&0\\1&0&0\\0&0&0\end{pmatrix} & \begin{pmatrix}0&0&1\\0&0&0\\0&0&0\end{pmatrix}\end{bmatrix}$$

$$\begin{bmatrix} & \begin{pmatrix}1&0&0\\0&-1&0\\0&0&0\end{pmatrix} \\ \begin{pmatrix}0&1&0\\1&0&0\\0&0&0\end{pmatrix} & \begin{pmatrix}0&-1&0\\1&0&0\\0&0&0\end{pmatrix}\end{bmatrix} \quad \begin{bmatrix} & \begin{pmatrix}0&0&0\\0&0&-i\\0&i&0\end{pmatrix} \\ \begin{pmatrix}0&1&0\\1&0&0\\0&0&0\end{pmatrix} & \begin{pmatrix}0&0&-i\\0&0&0\\0&0&0\end{pmatrix}\end{bmatrix}$$

$$\begin{bmatrix} & \begin{pmatrix}0&0&1\\0&0&0\\1&0&0\end{pmatrix} \\ \begin{pmatrix}0&1&0\\1&0&0\\0&0&0\end{pmatrix} & \begin{pmatrix}0&0&0\\0&0&0\\0&0&0\end{pmatrix}\end{bmatrix} \quad \begin{bmatrix} & \begin{pmatrix}\frac{1}{\sqrt{3}}&0&0\\0&\frac{1}{\sqrt{3}}&0\\0&0&\frac{-2}{\sqrt{3}}\end{pmatrix} \\ \begin{pmatrix}0&1&0\\1&0&0\\0&0&0\end{pmatrix} & \begin{pmatrix}0&\frac{1}{\sqrt{3}}&0\\\frac{1}{\sqrt{3}}&0&0\\0&0&0\end{pmatrix}\end{bmatrix}$$

Hmm. Well, that was… not particularly helpful? I was hoping for some kind of interlinking pattern? Not at all what I got…

Note from hbar chat on Physics SE: Apparently, though SU(2) has a nice interpretation (diffeomorphism) in terms of a higher dimensional sphere, such a diffeomorphism does not exist for SU(3), as described in this link from s.harp:

"Topology of SU(3)", asked 2011-07-02:
http://mathoverflow.net/questions/69352/topology-of-su3

Someone (?) also provided a possible connection to Clifford algebras, captured in this one cryptic formula:

https://wikimedia.org/api/rest_v1/media/math/render/svg/dbbc01e36c5d4771247c12844d2bb0e4b0ebb145

2016-10-04.~23:00 Tue (lost exact time to auto-update)]

2016-10-05.09:06 Wed [

[Not sure if these stupid date fields are worth the trouble. I just lost all the exact start-end times for Mon and Tue due to an auto-update-on-open feature that I did not realize existed. It may be safer and easier just to type dates in, so there are not lost if I forget to Shift-Ctrl-F9 each one.]

2016-10-06.10:06 Thu [

2016-10-06.10:58 Thu [

OK, I just created a VBA macro that inserts a date, converts the Style to "ts timestamp", and collapses the field into simple text. This seems to work much, much better. I access it via Alt-h-y.

The macro can be edited via Alt-F11. Here's what I'm using:

```
Sub InsertDateAndTimeAtIP()
Selection.Style = "ts timestamp"
Selection.InsertAfter Format(Now(), "yyyy-MM-dd.HH:mm DDD")
Selection.Collapse wdCollapseEnd
End Sub
```

2016-10-06.11:01 Thu [

OK, Alt-h-y seems to be working fine. The open bracket is hand-added, with the idea that I can add "[" (start or open), "]" (end or close), or just a date to make when a point was reached.

2016-10-06.11:13 Thu]

2016-10-06.13:01 Thu [

Below is a very short example of I think the simplest possible (and I suspect original) meaning of "outer product", which is the same thing as the "tensor product": The matrix product $\boldsymbol{u}\boldsymbol{v}^T$, that is, a row vector times a column vector to give a square matrix, versus $\boldsymbol{v}^T\boldsymbol{u}$, col-times-row, which gives a single scalar (the inner product?):

Is there a geometric meaning to the outer product of two vectors?

Q: Define two vectors $\boldsymbol{v}$ and $\boldsymbol{u}$ in $\mathbb{R}^3$. I know the geometric meaning of the inner and cross product. Is there a meaning to the matrix resulting from $\boldsymbol{uv}^T$?

A: For any vector x,

$$uv^T(x) = (v \cdot x)u$$

That is, if u and v are unit vectors, $uv^T(x)$ is the component of x in the u direction, taken into the v direction.

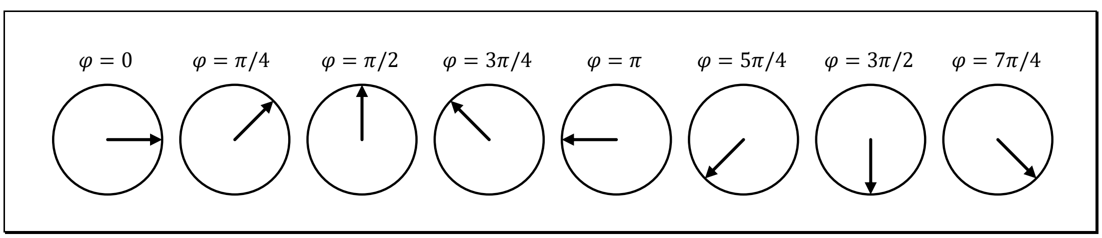
This interpretation makes for a neat understanding of singular value decomposition.

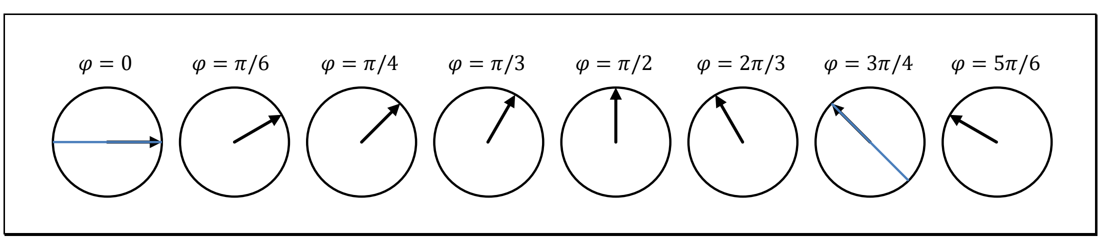
So, I recall exploring these same matrix-generating multiplications once before and wondering what the matrix outcome was, e.g., if $u = (a\ b),\ \ v = (c\ d)$, then $uv^T,\ \ u^Tv$ look like this:

uv^T	$\begin{pmatrix} a & b \end{pmatrix} \begin{pmatrix} c \\ d \end{pmatrix} (ac + bd)$	"Inner product" (scalar)? It fits the definition, since it's zero if the two use different basis vectors, max if the same.
u^Tv	$\begin{pmatrix} a \\ b \end{pmatrix} \begin{pmatrix} c & d \end{pmatrix} \begin{pmatrix} ac & ad \\ bc & bd \end{pmatrix}$	"Outer product" (square matrix)? The terminology fits, since the matrix gets larger instead of collapsing to scalar.

2016-10-06.22:23 Thu [

An interesting example of the outer product is a rotating vector:





$$\begin{array}{c}\begin{pmatrix}1 & 0\end{pmatrix}\\ \begin{pmatrix}1\\0\end{pmatrix}\begin{pmatrix}1 & 0\\0 & 0\end{pmatrix}\end{array}\quad \begin{array}{c}\begin{pmatrix}\sqrt{\frac{3}{4}} & \sqrt{\frac{1}{4}}\end{pmatrix}\\ \begin{pmatrix}\sqrt{\frac{3}{4}}\\ \sqrt{\frac{1}{4}}\end{pmatrix}\begin{pmatrix}\frac{3}{4} & \sqrt{\frac{3}{16}}\\ \sqrt{\frac{3}{16}} & \frac{1}{4}\end{pmatrix}\end{array}\quad \begin{array}{c}\begin{pmatrix}\sqrt{\frac{1}{2}} & \sqrt{\frac{1}{2}}\end{pmatrix}\\ \begin{pmatrix}\sqrt{\frac{1}{2}}\\ \sqrt{\frac{1}{2}}\end{pmatrix}\begin{pmatrix}\frac{1}{2} & \sqrt{\frac{1}{4}}\\ \sqrt{\frac{1}{4}} & \frac{1}{2}\end{pmatrix}\end{array}\quad \begin{array}{c}\begin{pmatrix}\sqrt{\frac{1}{4}} & \sqrt{\frac{3}{4}}\end{pmatrix}\\ \begin{pmatrix}\sqrt{\frac{1}{4}}\\ \sqrt{\frac{3}{4}}\end{pmatrix}\begin{pmatrix}\frac{1}{4} & \sqrt{\frac{3}{16}}\\ \sqrt{\frac{3}{16}} & \frac{3}{4}\end{pmatrix}\end{array}$$

$$\begin{array}{c}\begin{pmatrix}0 & 1\end{pmatrix}\\ \begin{pmatrix}0\\1\end{pmatrix}\begin{pmatrix}0 & 0\\0 & 1\end{pmatrix}\end{array}\quad \begin{array}{c}\begin{pmatrix}-\sqrt{\frac{1}{4}} & \sqrt{\frac{3}{4}}\end{pmatrix}\\ \begin{pmatrix}-\sqrt{\frac{1}{4}}\\ \sqrt{\frac{3}{4}}\end{pmatrix}\begin{pmatrix}\frac{1}{4} & -\sqrt{\frac{3}{16}}\\ -\sqrt{\frac{3}{16}} & \frac{3}{4}\end{pmatrix}\end{array}\quad \begin{array}{c}\begin{pmatrix}-\sqrt{\frac{1}{2}} & \sqrt{\frac{1}{2}}\end{pmatrix}\\ \begin{pmatrix}-\sqrt{\frac{1}{2}}\\ \sqrt{\frac{1}{2}}\end{pmatrix}\begin{pmatrix}\frac{1}{2} & -\sqrt{\frac{1}{4}}\\ -\sqrt{\frac{1}{4}} & \frac{1}{2}\end{pmatrix}\end{array}\quad \begin{array}{c}\begin{pmatrix}-\sqrt{\frac{1}{4}} & \sqrt{\frac{3}{4}}\end{pmatrix}\\ \begin{pmatrix}-\sqrt{\frac{1}{4}}\\ \sqrt{\frac{3}{4}}\end{pmatrix}\begin{pmatrix}\frac{1}{4} & -\sqrt{\frac{3}{16}}\\ -\sqrt{\frac{3}{16}} & \frac{3}{4}\end{pmatrix}\end{array}$$

2016-10-07.00:06 Fri]

2016-10-07 Fri (or later; date lost due to auto update) [

Date: Fri, 2 Sep 2016 16:32:49 -0400
Subject: Re: the the search for dark matter: interview of tracy slatyer
From: Terry Bollinger <terrybollinger@gmail.com>
To: Roger Duncan <roger.duncan@gmail.com>
Cc: Jack Thibeault <jack.thibeault@gmail.com>

On Fri, Sep 2, 2016 at 3:54 PM, Roger Duncan <roger.duncan@gmail.com> wrote:

Q&A <https://www.quantamagazine.org/tag/qa/>
A Seeker of Dark Matter's Hidden Light

The physicist Tracy Slatyer is searching for faint wisps of dark matter annihilating in the early universe and perhaps in hiding places closer to home.

Roger (and Jack),

Actually, last week I accidentally came up with a really interesting theoretical candidate for dark matter, literally without meaning to? It was in such an odd context that I can assure you it's not being explored by any of the current models. The reason why is rather amusing.

For me it was an unexpected empty slot in something else I was doing. That slot seems to have a lot of the right properties for dark matter, better than most models in fact. However, I need to put a lot more meat into the initial hypothesis that led to the framework with that empty slot.

Nonetheless, I was arrogant enough for at least that first day to go around thinking "hah! i know what dark matter is and no one else does!"

If I'm right, the searches for self-annihilation of dark particles are utterly pointless. The dark matter particles I'm looking at will never form pairs, and in the most likely scenario (there is more than one) they will not annihilate each other even if they collide head on. These puppies are truly, truly DARK, darker than anything else I've seen proposed.

That does not mean they are unverifiable, though. They have specific statistical properties that should show up in astronomical observations of the overall properties of a broad range of dark matter clouds.

Cheers,
Terry

2016-11-14 Facebook posting:

https://www.facebook.com/terry.b.bollinger/posts/10211130758894406
https://terrybollinger.wordpress.com/2016/11/14/a-four-particle-theory-of-dark-matter/

David Emery, the cartoon http://xkcd.com/1758/ in your posting on my wall is referring to MOND, MOdified Newtonian Dynamics. MOND makes remarkably accurate predictions for certain types of star associations, ones that are much better than dark matter frankly. But for other contexts it does not work well at all, forcing re-creation of the dark matter premise. A good summary of how odd the issues can get, including apparently a complete (!) lack of dark matter near earth, can be found here: http://www.livescience.com/19796-dark-matter-alternatives.html. Incidentally, while the science at that site seems quite good, the advertising is... a bit unusual?... for a science site.

Sometimes I like to drop bits of things I'm working on, so here's one such example. The following predictions are entirely my own, and not even remotely similar to standard dark matter theory.

There are four types of dark matter particles. All are very stable, low mass, and almost completely non-reactive, both with each other and with ordinary matter. They are distinguished by a velocity "charge" that has no direct analogy with ordinary matter. One group has zero v-charge and so can be stationary in the same fashion as ordinary matter.

A second group has a v-charge, a velocity charge, of c, that is of the speed of light. As a consequence this type stays largely disassociated from ordinary matter, and for that matter from the other form of dark matter.

However, the most interesting classes of dark matter particles are the two types with v-charges that are intermediate between 0 and c. These two intermediate types are doomed to move always at significant fractions of the speed of light relative to the local very-large-scale mass frame of the universe. These particles can be slowed or accelerated from those states, just like ordinary matter can be slowed or accelerated, but their rest states (by which I mean the states for which their total mass-energy is minimized at the very large scale) is to always be in motion at very large fractions of the speed of light.

It is the spectrum of v-charges that allows the three non-c varieties of dark matter to synchronize in interesting and highly dynamic ways with very-large-scale with rotating systems, spiral galaxies in particular. Since they can be slowed down to more ordinary velocities, they are capable of entering into orbit around a galaxy... but only at a high energy cost, one that siphons energy away from ordinary matter while simultaneously increasing their apparent gravitational masses, just like the mass increases seen in ordinary particles in a particle accelerator. This allows them to participate in galactic rotations, but only in a very peculiar way in which they act as mass-energy reservoirs for the overall rotation of the system.

The existence of three different lowest-energy velocity minimums (specifically ordinary matter plus the zero v-charge form of dark matter, and the two non-zero, non-c forms of dark matter) in a rotating system creates an almost classic situation for generating large-scale oscillations. These oscillations, which can be quite diverse in form, are responsible for the lovely variety and at times rather inexplicable structures seen in spiral galaxies, which represent various stable oscillation states of various mixes and total galactic angular momenta for the three matter and dark-matter velocity states. Our visible universe rides on top of the component of the wave characterized by energy being lowest when particles are at rest relative to the overall galaxy and local galaxy clusters -- that is, ordinary matter and zero v-charge dark matter.

This gradated rotational synchronization is mediated solely by gravity -- there is in fact almost no other way to interact with dark matter -- and so it takes a very long time to develop. The very-large-scale density waves of synchronized non-c (zero, fast, and faster) matter and dark matter form during this synchronization process. These dark matter density waves are associated both with the complex visible structure of spiral galaxies, and also with the near absence of dark matter in some galactic regions.

Galactic collisions disrupt the mature forms of these graduated, multi-velocity dark matter waves. Elliptical galaxies represent the end stage, at which point the synchronization of dark matter and ordinary matter that mimics MOND is pretty much completely disrupting, and replaced by a chaotic cloud whose behavior is better characterized as an amorphous mix of "cold" (zero v-charge) and "warm" (two levels of non-c v-charge) dark matter, with the warm varieties typically having much higher velocities than they would in spiral galaxies. These are the clouds that at galactic and larger scales provide the best gravitational lensing, since they are smoother (more isotropic) at these larger scales. From an energy perspective, the ideal end state would be a galaxy cluster so huge and dense that that the warm forms of dark matter can move at their natural large fractions of the speed of light, yet remain in orbit. This also means there would be two unique preferred sizes. One size would enable direct orbiting by the slower from of dark matter, and a much larger galaxy cluster size would enable direct orbiting by the "warmer" form of dark matter particles. I'm pretty sure that the known universe does not include either of these huge sizes of galaxy super-clusters, at least not yet.

The strangely filamentary structure of the large-scale universe is again a reflection of the odd dynamics that are provided in particular by the two intermediate c-charge varieties of dark matter, which can never rest relative to their local (but very large scale) gravitational rest frames. And yes, that creates odd conundrums for special relativity, but only in the sense that it distinguishes one frame from others. That's already true from energy minimization arguments, which make the CMB unique for representing the true energy minimum frame for the large-scale local universe, but for the two intermediate velocity forms of dark matter that uniqueness becomes a lot more apparent and impactful.

Finally, when I mentioned that gravity is "almost" the only way to interact with dark matter, the "almost" was referring to interactions with the Higgs boson. Since dark matter has mass, it necessarily must be capable of interacting with the Higgs. I do not know if that could lead to scenarios that would allow the LHC to detect dark matter, but there is certainly an interesting possibility in that approach. Such experiments would be complicated by the observation that we seem to be in a dark-matter-poor region of the overall dark matter resonance structure of our galaxy.

Admin note: I've removed Facebook from my phone, and I will only be logging into it about once a week or so, maybe less. My postings here likely will be rare and mostly photos. Responses will be even rarer.