that's not useless, it's just... unusual

Holly Cummins
@holly_cummins

A GARAGE THAT DEVELOPERS CAN CALL HOME FOR CLOUD INNOVATION

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LAST MONTH MY company opened the first Bluemix Garage, a place where developers, product managers and designers from the smallest startups to the largest companies can congregate, network and collaborate to build the


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London, United Kingdom

Founded Nov 26, 2007

About us...

Java Developers	5,341
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Upcoming Meetups	2
Past Meetups	515
Our calendar	

Organizers:

Barry Cranford, Alex Blewitt, Anji Conroy, Ben Evans, Bruce Durling

Don't miss this - Mad Scientists event 24 March

From:	Maggie C.
Sent on:	Sunday, March 20, 2016 11:52 AM

Hi guys,

Have you signed up for Mad Scientists yet? Our signup page http://www.meetup.com/Londonjavacommunity/events/229340114/ was written when we had the bare-bones of the event in place, but now there is lots of very cool detail to give you.

The event is being run in collaboration with IBM and is coming up fast (Thursday 24th March). It features:

- emotional robots
- mind-controlled BB-8
- tweet controlled drones
- zombie bunnies video game
- DIY IoT devices
- an awesome competition (the prize is a BB-8)
- and much. much more.

There's a web page you really need to check out http://mad-scientists.mybluemix.net/#main It has details of the talks (10+), the demos (20+) and the competition. (The prize is truly awesome - there's a You Tube video here https://www.youtube.com/watch?v=K-4mp_e5v4A that you should check out).

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am I *mad* enough?

imposter syndrome

am I *mad* enough?

a novel form of
imposter syndrome

am I <u>mad</u> enough?

Approximate Quantum Cloning with Nuclear Magnetic Resonance

Holly K. Cummins,[1] Claire Jones,[2] Alistair Furze,[2] Nicholas F. Soffe,[3]
Michele Mosca,[4] Josephine M. Peach,[2] and Jonathan A. Jones[1,3,*]

[1] *Centre for Quantum Computation, Clarendon Laboratory, University of Oxford, Parks Road, OX1 3PU, United Kingdom*
[2] *Dyson Perrins Laboratory, University of Oxford, South Parks Road, OX1 3QY, United Kingdom*
[3] *Oxford Centre for Molecular Sciences, Central Chemistry Laboratory, University of Oxford, South Parks Road, OX1 3QTH, United Kingdom*
[4] *Department of Combinatorics and Optimization, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada*

(Dated: July 22, 2013)

Here we describe a Nuclear Magnetic Resonance (NMR) experiment that uses a three qubit NMR device to implement the one to two approximate quantum cloning network of Bužek *et al.*

PACS numbers: 03.67.-a, 76.60.-k, 82.56.Jn

Quantum information processing [1] has been the subject of much recent interest, not only because it offers new modes of computation and communication, but also because quantum information differs from classical information in several fundamental ways. One important example is the fact that it is impossible to accurately clone (copy) an unknown quantum state [2], and so quantum bits (qubits) cannot be duplicated. It is, however, possible to prepare an approximate copy [3], and several schemes for optimal approximate cloning have been developed. Nuclear Magnetic Resonance (NMR) [4, 5, 6] has already been used to demonstrate simple quantum information processing methods [7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24], and here we de-

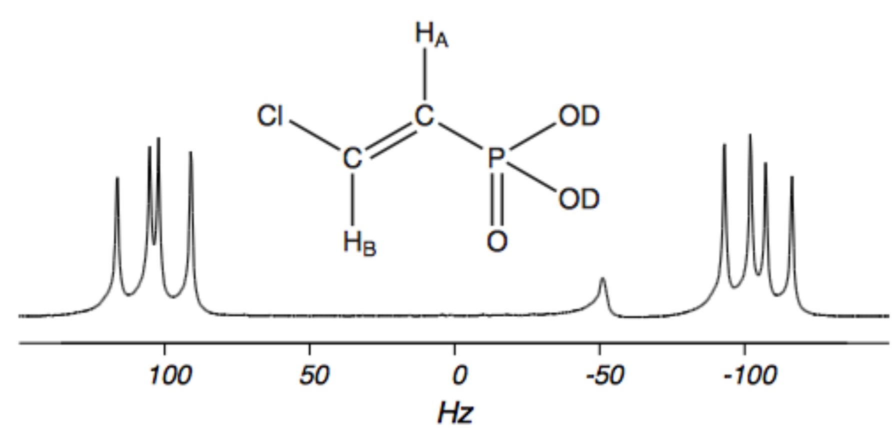

FIG. 2: The three qubit system provided by E-(2-chloroethenyl)phosphonic acid dissolved in D_2O and its ^1H NMR spectrum. The broad peak near −50 Hz is a folded signal arising from residual HOD.

Approximate Quantum Cloning with Nuclear Magnetic Resonance

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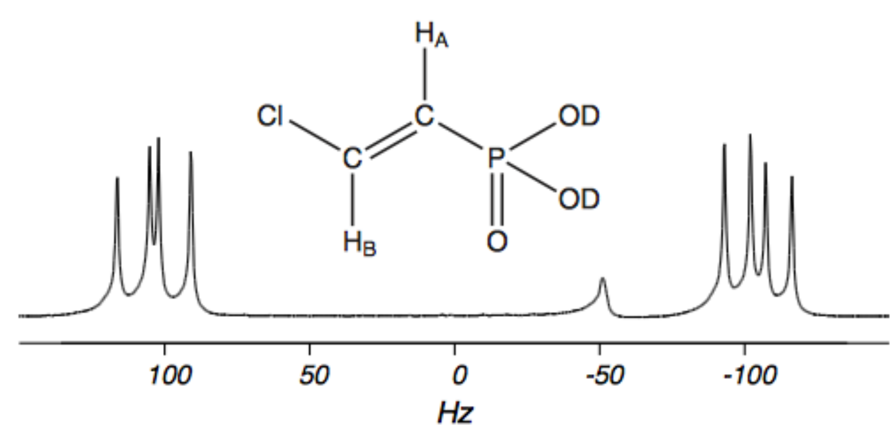

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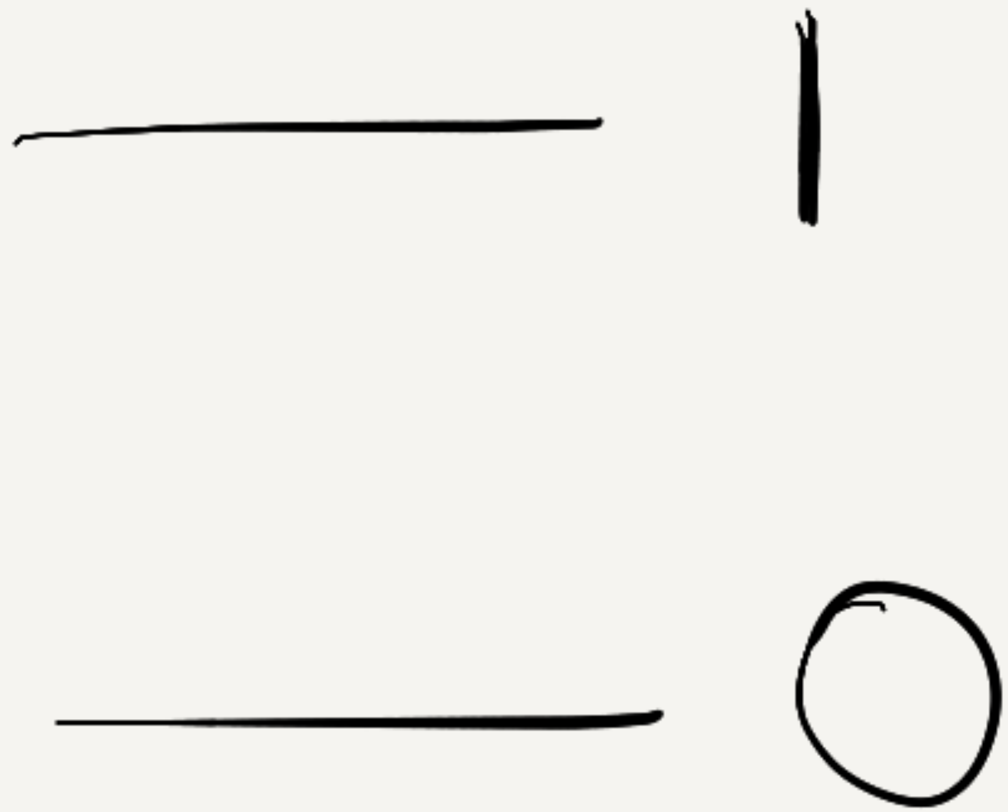
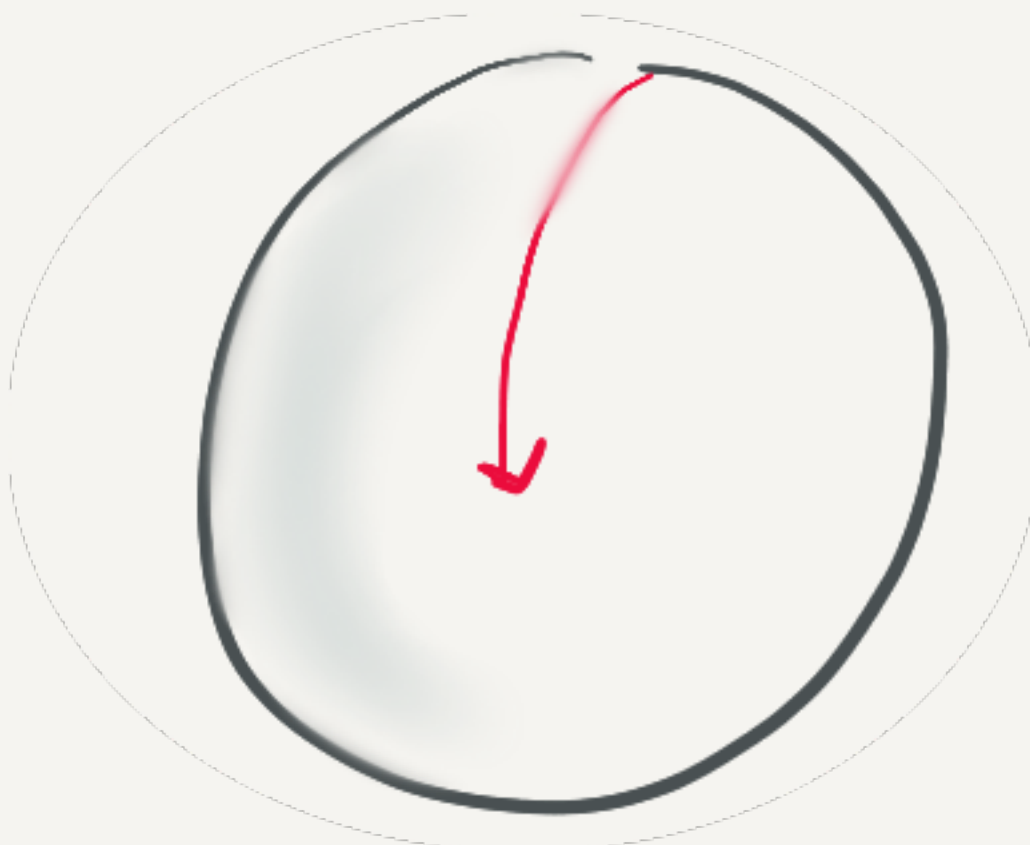
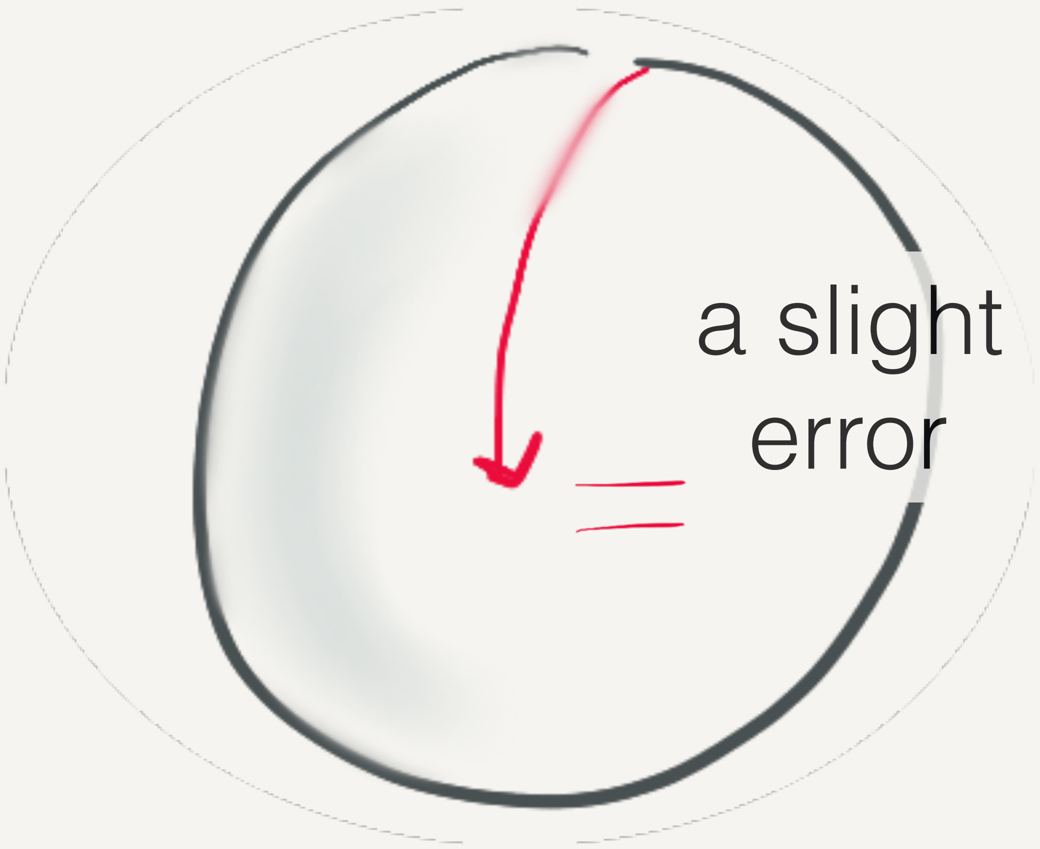


a classical bit

a quantum bit



a state change



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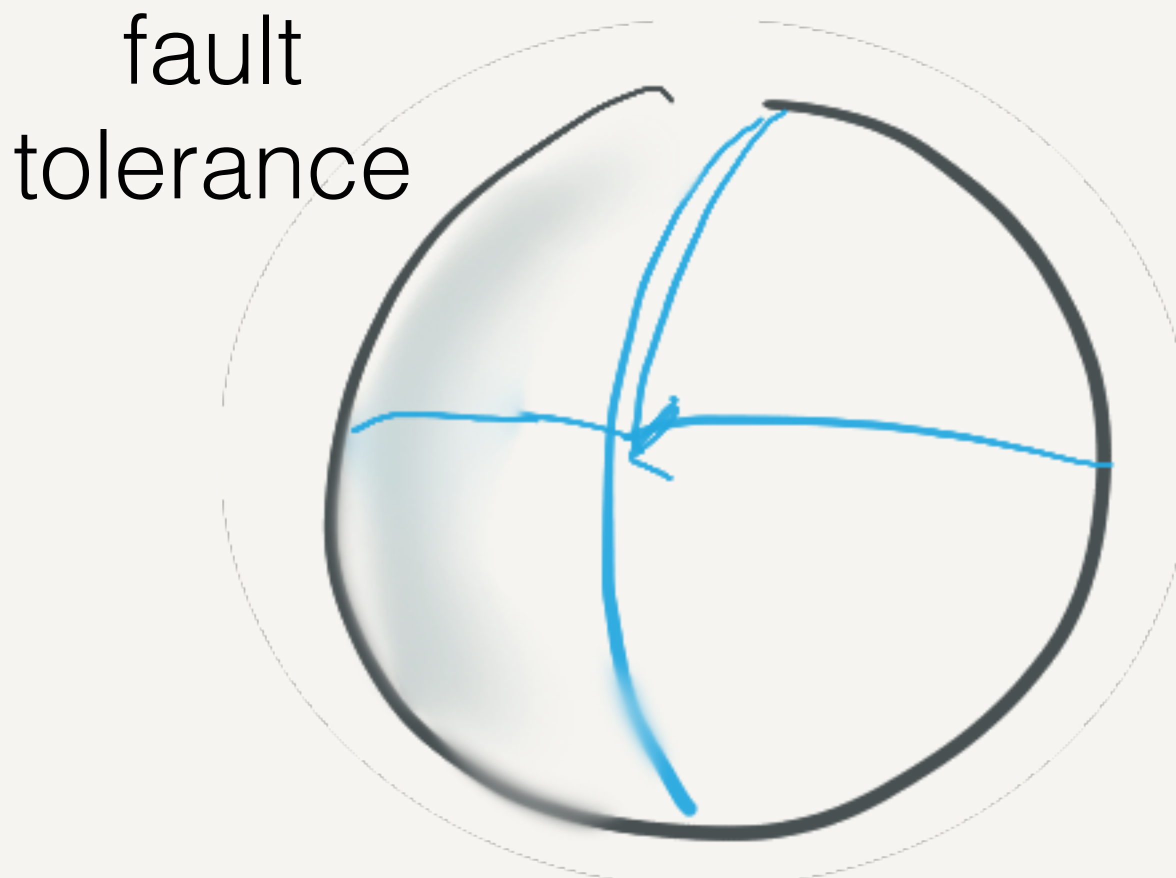
composite rotations



composite rotations

Resonance Offset Tailored Pulses for NMR Quantum Computation

H. K. Cummins

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Oxford Centre for Molecular Sciences, New Chemistry Laboratory, South Parks Road, Oxford, OX1 3QT, UK
E-mail: jonathan.jones@qubit.org

We describe novel composite pulse sequences which act as general rotors and thus are suitable for nuclear magnetic resonance (NMR) quantum computation. The Resonance Offset Tailoring To Enhance Nutations approach permits perfect compensation of off-resonance errors at two selected frequencies placed symmetrically around the frequency of the RF source.

Key Words: NMR, quantum computer, composite pulse, off-resonance.

These composite pulses give excellent compensation of off-resonance effects at small offset frequencies, such as those found for ^{1}H nuclei, but are of no use for the much larger off resonance frequencies typically found for ^{13}C.

Fortunately when composite pulses are used for NMR quantum computation one great simplification can be made: it is only necessary that the pulse sequence perform well over a small number of discrete frequency ranges, corresponding to the resonance frequencies of the nuclei used to implement qubits; it is *not* necessary to design pulses which work well over the whole frequency range. In particular it is quite common in NMR quantum computation to

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Here we explain how Resonance Offset Tailoring To Enhance Nutations may be used to produce composite pulse sequences which give perfect compensation of off-resonance effects. These ROTTEN pulses act as perfect general rotors at two frequencies, offset from the RF frequency by $\pm\delta$, and are well suited to NMR quantum com-

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Tackling Systematic Errors in Quantum Logic Gates with Composite Rotations

Holly K. Cummins, Gavin Llewellyn, and Jonathan A. Jones*
Centre for Quantum Computation, Clarendon Laboratory,
University of Oxford, Parks Road, OX1 3PU, United Kingdom
(Dated: February 1, 2008)

We describe the use of composite rotations to combat systematic errors in single qubit quantum logic gates and discuss three families of composite rotations which can be used to correct off-resonance and pulse length errors. Although developed and described within the context of NMR quantum computing these sequences should be applicable to any implementation of quantum computation.

PACS numbers: 03.67.-a, 76.60.-k, 82.56.Jn

I. INTRODUCTION

Quantum computers [1] are information processing devices that use quantum mechanical effects to implement algorithms which are not accessible to classical computers, and thus to tackle otherwise intractable problems [2]. Quantum computers are extremely vulnerable to the effects of errors, and considerable effort has been expended on alleviating the effects of random errors arising from decoherence processes [3, 4, 5]. It is, however, also important to consider the effects of systematic errors, which arise from reproducible imperfections in the apparatus used to implement quantum computations.

The effects of systematic errors are clearly visible in nuclear magnetic resonance (NMR) experiments [6] which have been used to implement small quantum computers [7, 8, 9, 10, 11, 12]. Implementing complex quantum algorithms require a network of many quantum logic gates, which for an NMR implementation translates into even longer cascades of pulses. In these cases small systematic

it is only necessary to implement a small set of quantum logic gates, as more complex operations can be achieved by joining these gates together to form logic circuits. A simple and convenient set comprises a range of single qubit gates together with one or more two qubit gates, which implement conditional evolutions and thus logical operations [13].

NMR quantum computers are implemented [11] using the two spin states of spin-1/2 atomic nuclei in a magnetic field as the qubits. Transitions between these states, and thus single qubit gates, are achieved by the application of radio frequency (RF) pulses. Two qubit gates require some sort of spin–spin interaction, which in NMR is provided by the scalar spin–spin coupling (J coupling) interaction. While this does not have quite the form needed for standard two qubit gates, it can be easily sculpted into the desired form by combining free evolution under the background Hamiltonian (which includes spin–spin coupling terms) with the application of single qubit gates [11].

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The CORPSE pulse sequence appears to be the best approach for tackling small off-resonance errors (for large *known* off-resonance effects the resonance offset tailored, or ROTTEN, scheme [21] is preferable). For pulse length errors variations on the BB1 scheme of Wimperis [20] give the best results; the SCROFULOUS family of pulses is less effective, but does have the advantage of being considerably shorter.

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sensible paper

bonkers paper

Designing Robust Unitary Gates: Application to Concatenated Composite Pulse

Tsubasa Ichikawa,[1] Masamitsu Bando,[1] Yasushi Kondo,[1,2] and Mikio Nakahara[1,2]

[1] *Research Center for Quantum Computing, Interdisciplinary Graduate School of Science and Engineering, Kinki University, 3-4-1 Kowakae, Higashi-Osaka, Osaka 577-8502, Japan*

[2] *Department of Physics, Kinki University, 3-4-1 Kowakae, Higashi-Osaka, Osaka 577-8502, Japan*

We propose a simple formalism to design unitary gates robust against given systematic errors. This formalism generalizes our previous observation [Y. Kondo and M. Bando, J. Phys. Soc. Jpn. **80**, 054002 (2011)] that vanishing dynamical phase in some composite gates is essential to suppress pulse-length errors. By employing our formalism, we derive a new composite unitary gate which can be seen as a concatenation of two known composite unitary operations. The obtained unitary gate has high fidelity over a wider range of error strengths compared to existing composite gates.

PACS numbers: 03.65.Vf, 03.67.Pp, 82.56.Jn.

I. INTRODUCTION

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putation, which requ
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To tackle the latter problem, one may decompose a given unitary gate into a sequence of several unitary operations, whose time-ordered product reproduces the given unitary gate [22–32]. Then the sequence becomes robust

can be seen as a concatenation of two composite pulses derived in [30] and has high fidelity over a wide range in the error parameter space. This pulse sequence cannot

[24, 26].

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quences, which are robust against the most important systematic errors in a two-level system. Sec. IV is devoted to conclusion and discussions.

that they compose the SCROFULOUS when combined together. We call this concatenated pulse by CORPSE In SCROFULOUS-CCCP, or CIS-CCCP for short, in the following.

One could alternatively try a concatenation of three SCROFULOUS pulses under the condition that they compose the CORPSE. This pulse sequence is, however, not robust in the sense of Eq. (3): Each constituent

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PACS numbers: 03.65.Vf, 03.67.Pp, 82.56.Jn.

I. INTRODUCTION

Noise and errors a
of a quantum system
turbance to a quantu
tracting much attent
suppress noise have b
putation, which requ
tems [3]. Geometric
are based on holono
the other hand, erro
control parameters,
due to their importa

To tackle the latter problem, one may decompose a given unitary gate into a sequence of several unitary operations, whose time-ordered product reproduces the given unitary gate [22–32]. Then the sequence becomes robust

can be seen as a concatenation of two composite pulses derived in [30] and has high fidelity over a wide range in the error parameter space. This pulse sequence cannot
[24, 26].
s. In Sec. II, we
itary gates robust
ness of the GQGs
neralized to arbi-
ems in the contin-
lts in Abelian geo-
ustness conditions
fter which discrete
III, the developed
atenated pulse se-
quences, which are robust against the most important systematic errors in a two-level system. Sec. IV is devoted to conclusion and discussions.

that they compose the SCROFULOUS when combined together. We call this concatenated pulse by CORPSE In SCROFULOUS-CCCP, or CIS-CCCP for short, in the following.

One could alternatively try a concatenation of three SCROFULOUS pulses under the condition that they compose the CORPSE. This pulse sequence is, however, not robust in the sense of Eq. (3): Each constituent

ns

PHYSICAL REVIEW A **89**, 022341 (2014)

Optimal arbitrarily accurate composite pulse sequences

Guang Hao Low, Theodore J. Yoder, and Isaac L. Chuang
Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA
(Received 5 July 2013; revised manuscript received 15 January 2014; published 28 February 2014)

Implementing a single-qubit unitary is often hampered by imperfect control. Systematic amplitude errors ϵ, caused by incorrect duration or strength of a pulse, are an especially common problem. But a sequence of imperfect pulses can provide a better implementation of a desired operation, as compared to a single primitive pulse. We find optimal pulse sequences consisting of L primitive π or 2π rotations that suppress such errors to arbitrary order $O(\epsilon^n)$ on arbitrary initial states. Optimality is demonstrated by proving an $L = O(n)$ lower bound and saturating it with $L = 2n$ solutions. Closed-form solutions for arbitrary rotation angles are given for $n = 1,2,3,4$. Perturbative solutions for any n are proven for small angles, while arbitrary angle solutions are obtained by analytic continuation up to $n = 12$. The derivation proceeds by a novel algebraic and nonrecursive approach, in which finding amplitude error correcting sequences can be reduced to solving polynomial equations.

DOI: 10.1103/PhysRevA.89.022341 PACS number(s): 03.67.Pp, 82.56.Jn

There are very few sequences in the literature that allow for corrected arbitrary angle rotations [criterion (4) from our Introduction]. The classic examples SCROFULOUS [9] and the PB sequences [10] are only correct to $n = 1,2$, respectively.

computations useless.

Systematic amplitude errors, the consistent over- or under-rotation of a single-qubit unitary operation by a small factor ϵ, are one common control fault. The discovery of a protocol for the complete and efficient suppression of these errors would greatly advance the field of quantum control, with applications as far ranging as implementing fault-tolerant quantum computation and improving nuclear magnetic resonance spectra acquisition. Due to the broad scope of systematic

sequences, though. However, to find them one must relax criterion (4), which requires arbitrary rotations. For example, if one restricts attention to correcting π rotations in the presence of amplitude errors, Jones proved the impressive result that sequences with $L = O(n^{1.47})$ [3,7] are possible. Uhrig efficiently implements the identity operator in the presence of dephasing errors with $L = O(n)$ [14]. If we also relax the criterion (3) and settle for specialized class B sequences that take $|0\rangle$ to $|1\rangle$ (those we call inverting sequences), Vitanov

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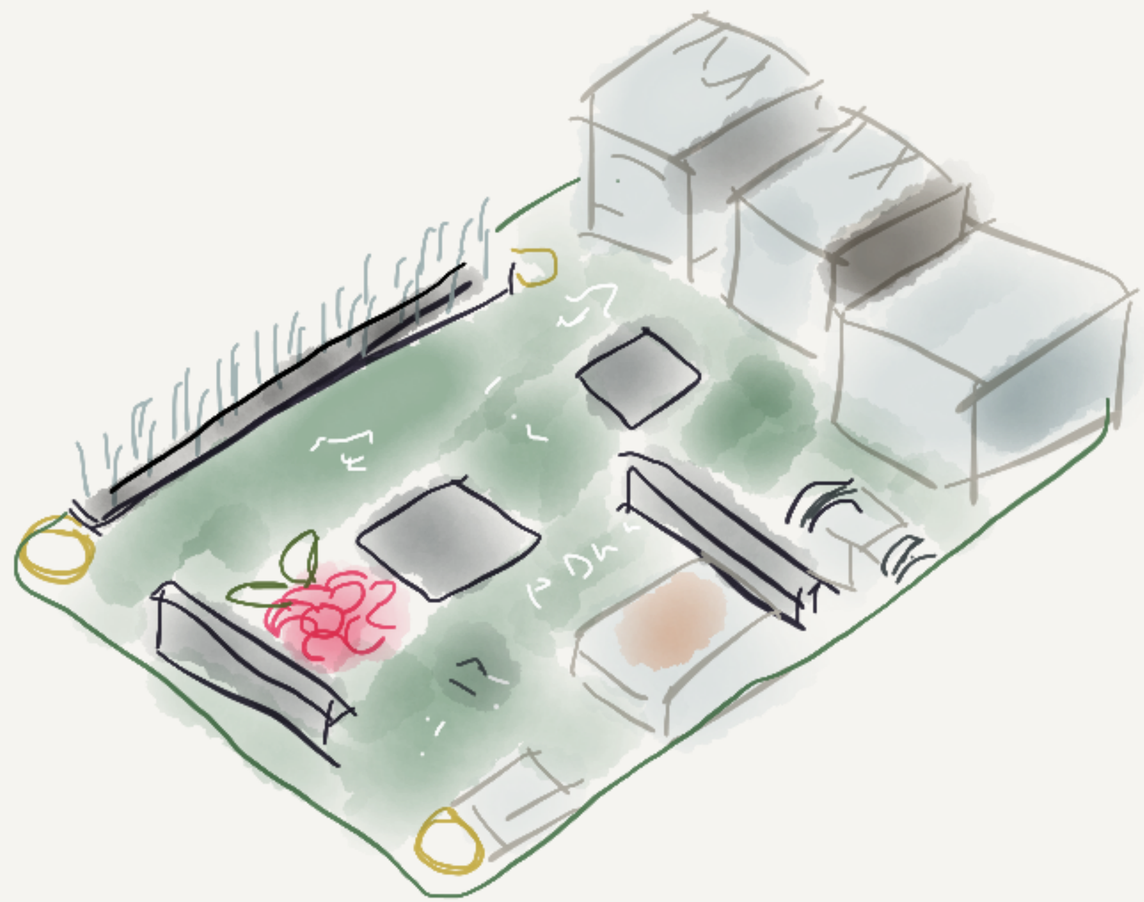

The WebSphere Hat

The WebSphere Hat

("the world's first wearable application server")

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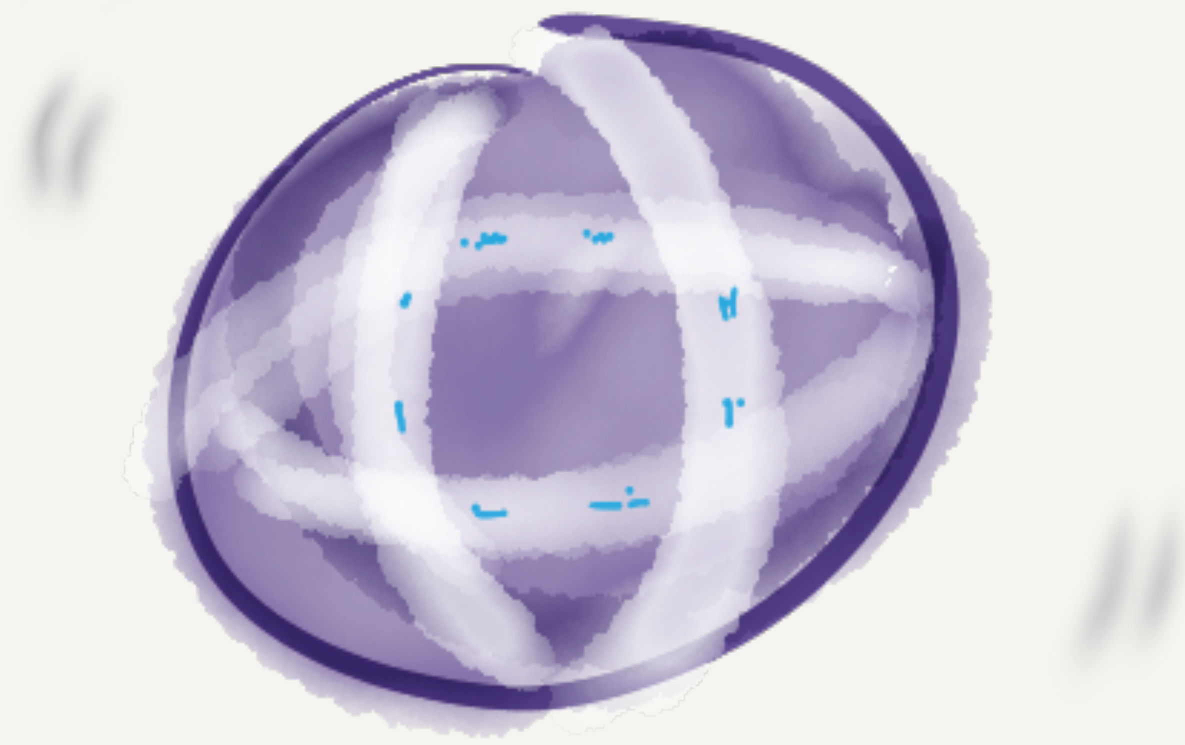
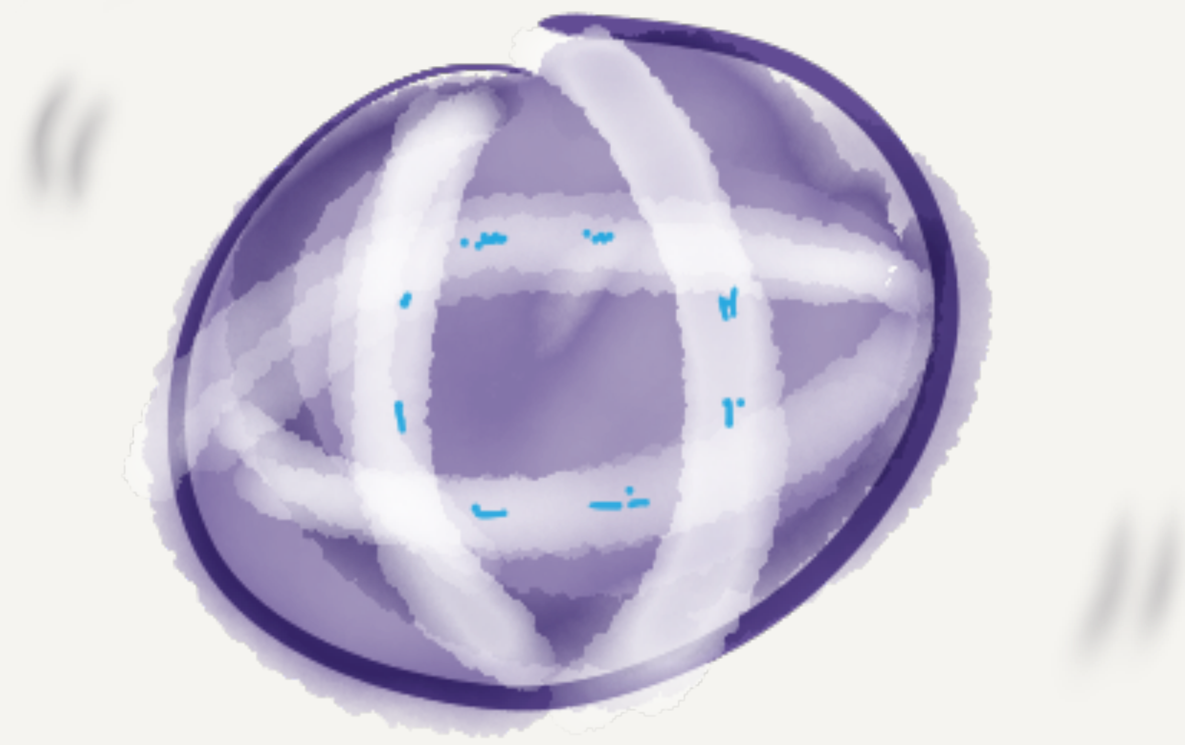
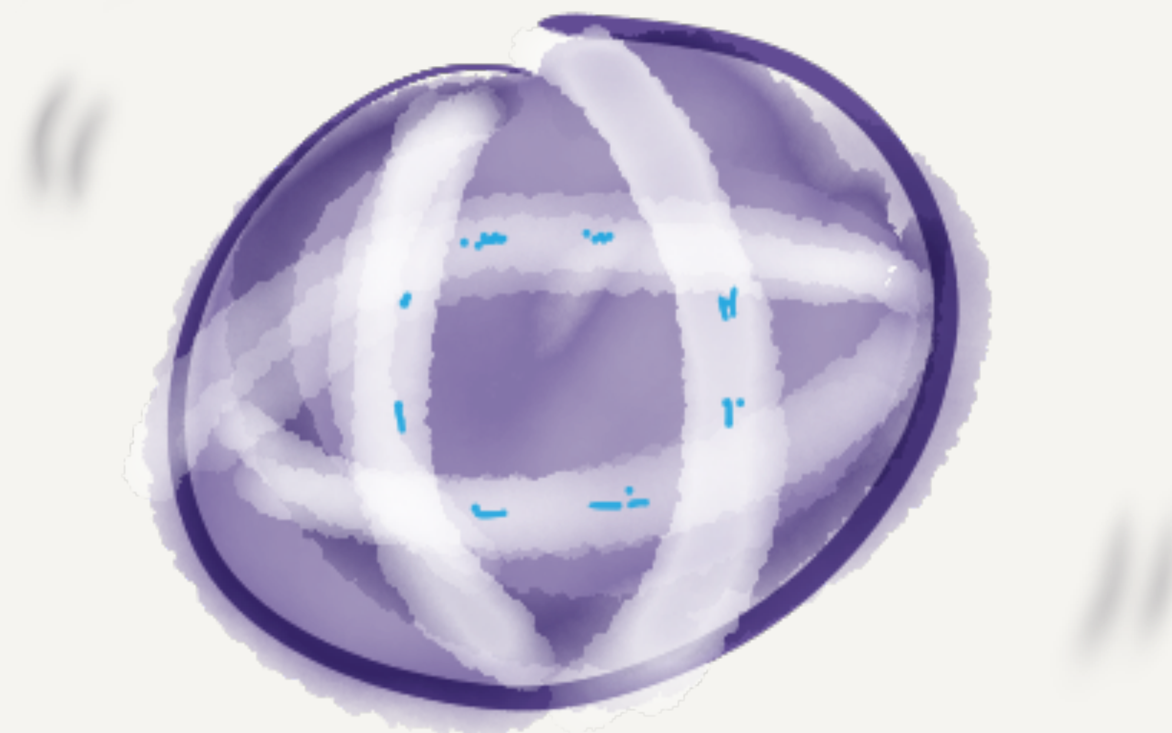




Presenting:

The WebSphere Sphere



Presenting:

The WebSphere Sphere

(“the cuddly throwable application server”)

photo courtesy of re:develop conference, Bournemouth http://pcduino.local

“Holly, why would anyone want an application server in a cuddly ball?”

–My Mother

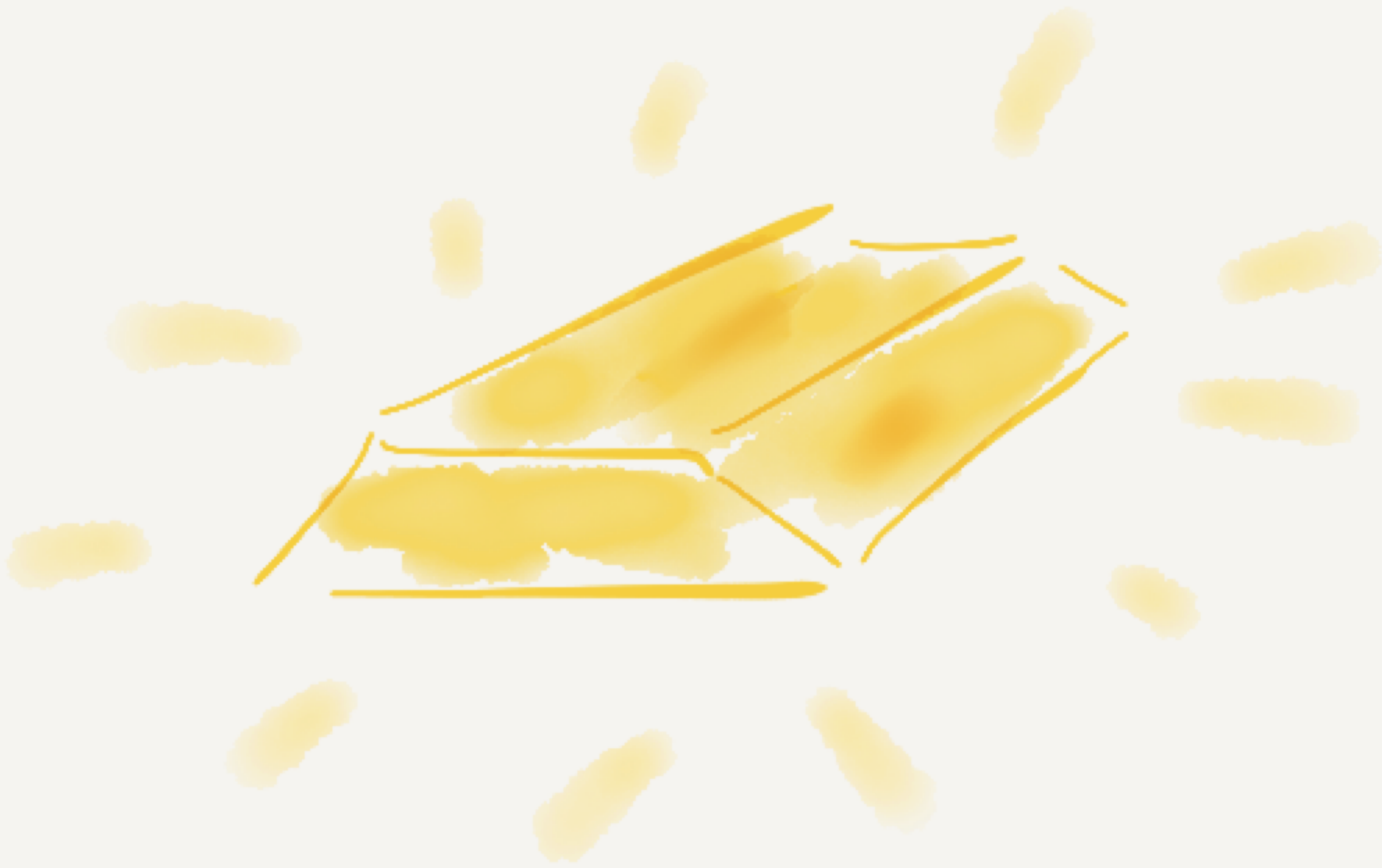
- [ ] scientist
- [ ] mad

- [x] scientist
- [ ] mad

✓ scientist

? mad

Hennig Brand



Periodic Table of the Elements

Atomic Number
Symbol
Name
Atomic Mass

2 IIA 2A	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8	9 VIII 8	10	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A
4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998
12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453
20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904
38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904
56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987
88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown

Lanthanide Series	57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.243	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 L Lut 17
Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 L Lawr [2

Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide

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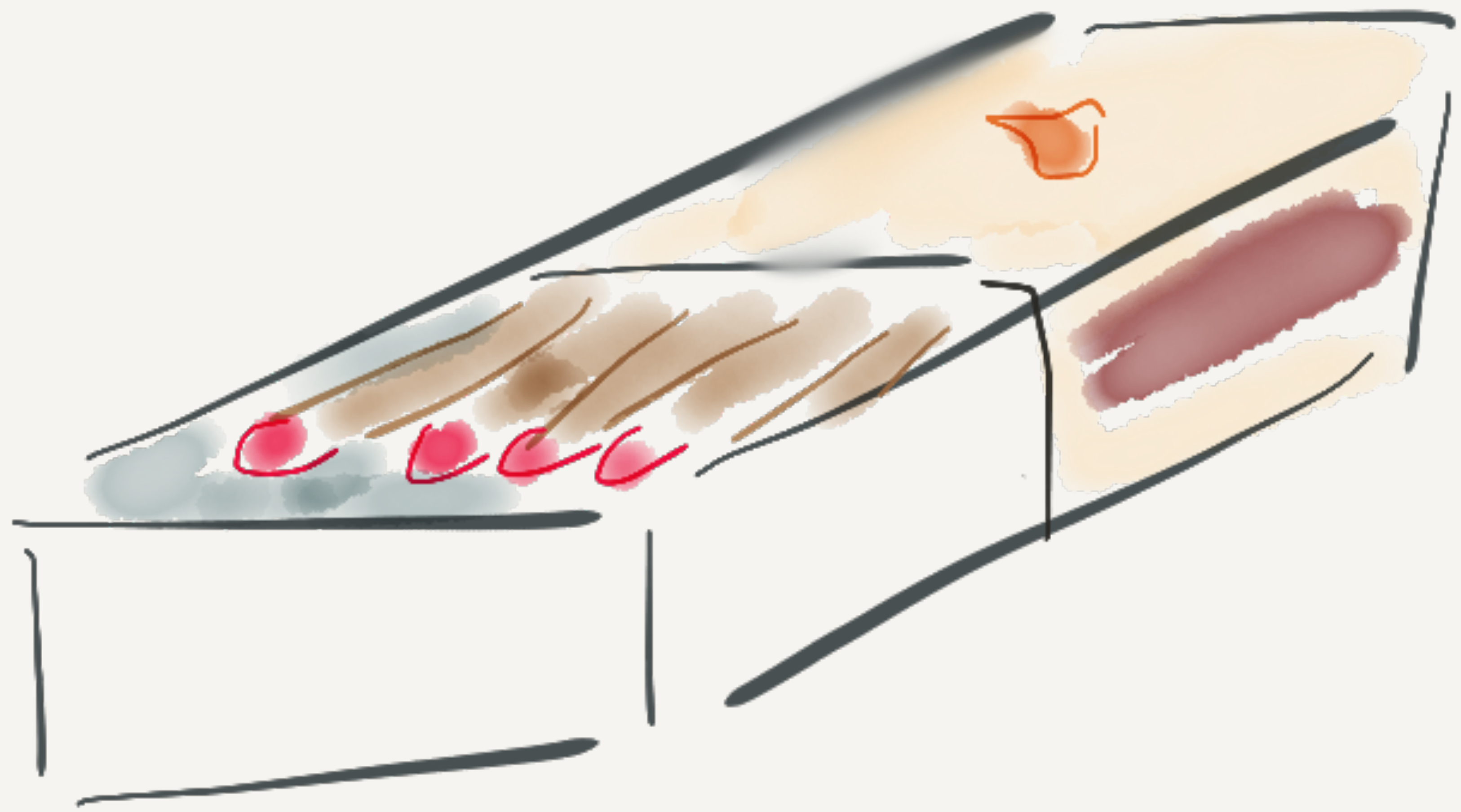
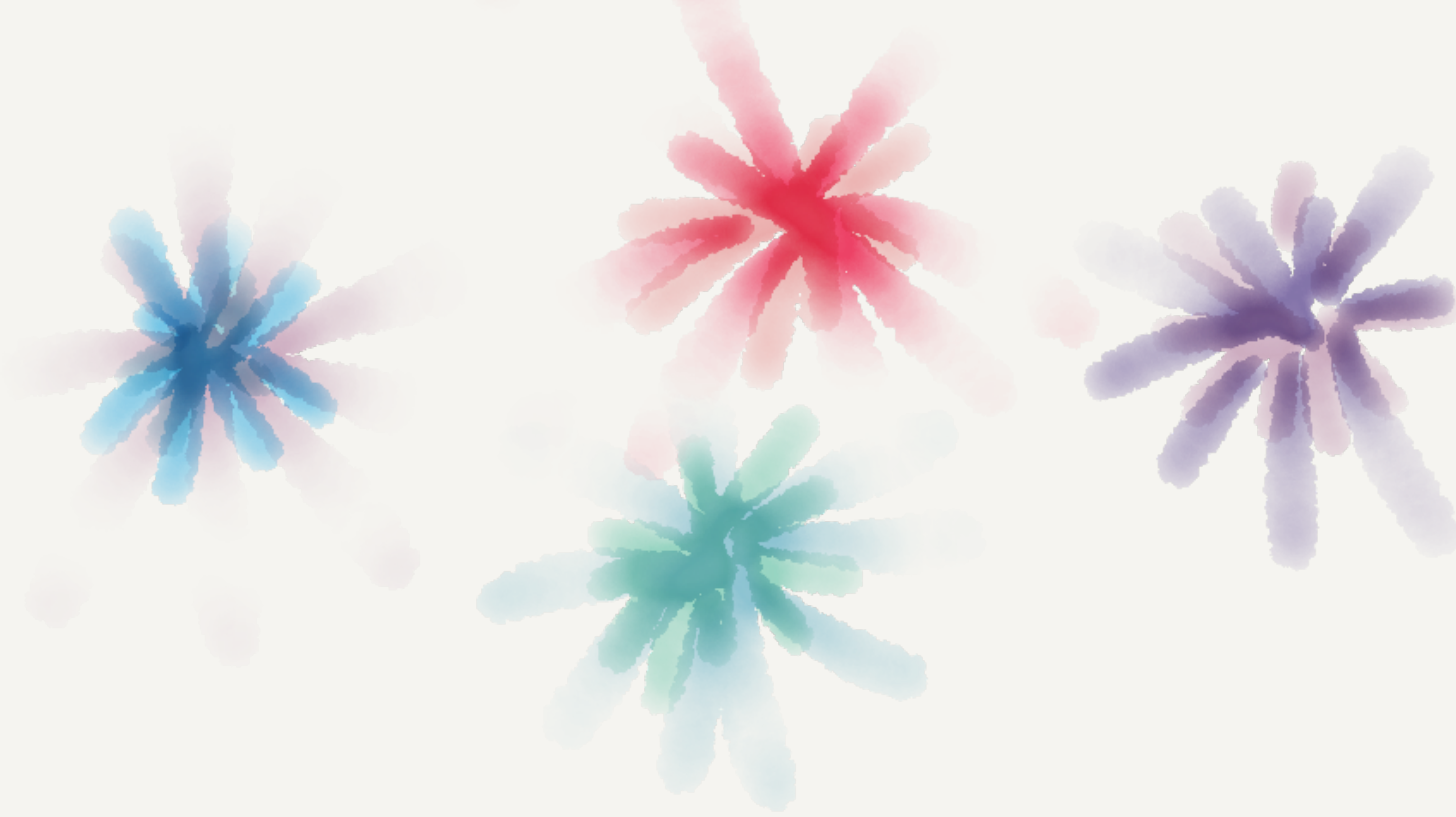
C
Carbon
12.011
N
Nitrogen
14.007
O
Oxygen
15.999
14
Si
Silicon
28.086
15
P
Phosphorus
30.974
16
S
Sulfur
32.066
32
Ge
Germanium
33
As
Arsenic
34
Se
Selenium

"Who wakes up and thinks 'I know, today I'll boil my urine to see what happens'?!"

–Melisse, my uni roommate



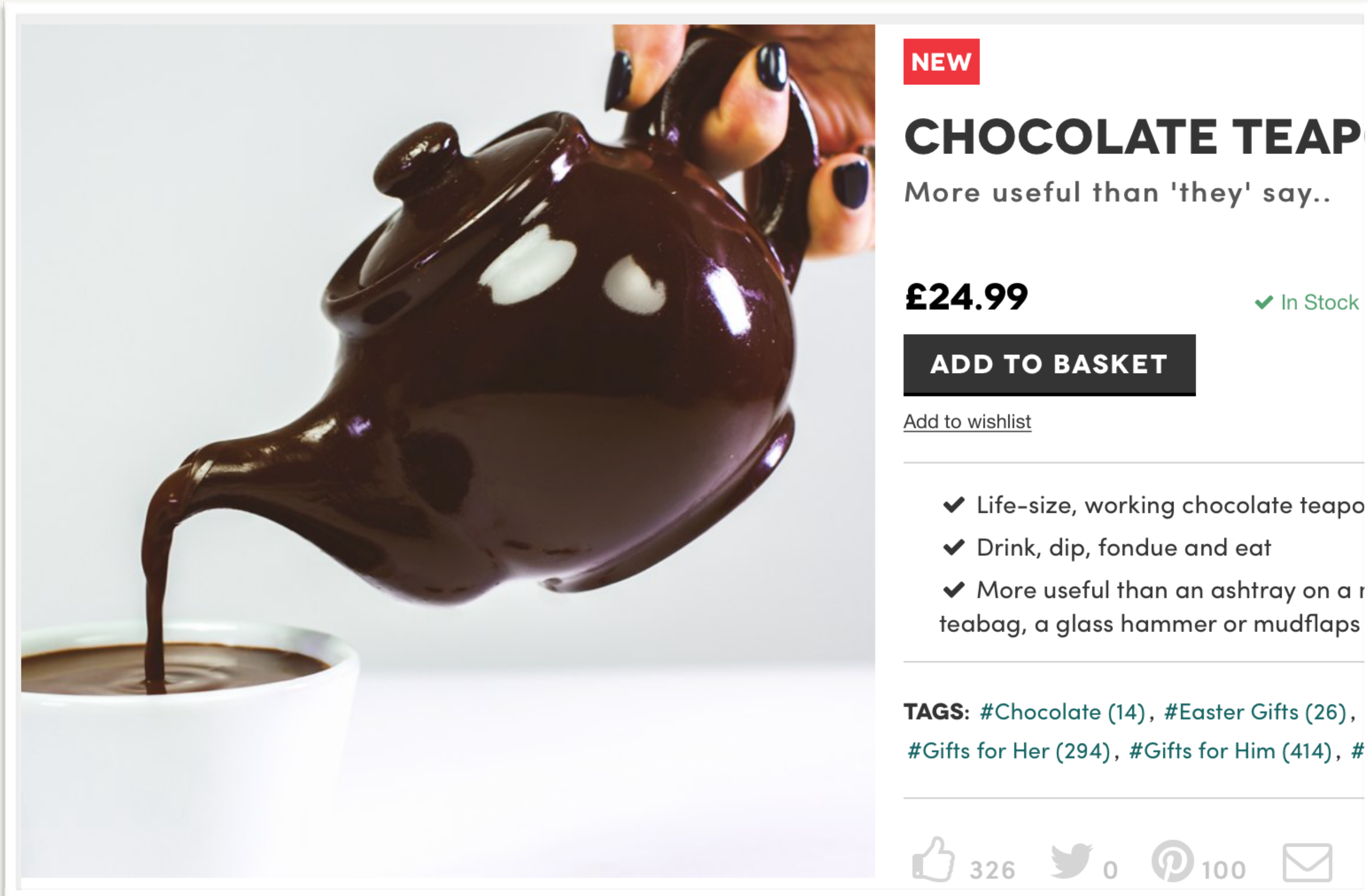


useless = useful?

As useless as a …

As useless as a …

chocolate teapot.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"I'm going to do the 4 deserts run. I'll have to run though bleeding blisters, deal with toenails falling off, and I'll be vomiting - in the best case."

— Simon Wheatcroft


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