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The Sakharov Conditions, Disruptive Technologies, and Human Rights

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Introduction

This paper explores the interplay between human rights, technology, and disruptive political change. Ever-increasing access to trusted information and rapid mass communication mechanisms, through smartphones and similar technologies, provide catalysts that can drive rapid political changes.

The context for this discussion is set by a remarkably prescient quote [1] from a piece written in 1974 by Andrei Sakharov that bears directly on the topics explored below. Bear in mind that this was written long before the advent of the personal computer, the Internet, or cell phones.

> *"I foresee a universal information system (UIS), which will give everyone access at any given moment to the contents of any book that has ever been published or any magazine or any fact. The UIS will have individual miniature-computer terminals, central control points for the flood of information, and communication channels incorporating thousands of artificial communications from satellites, cables, and laser lines. Even the partial realization of the UIS will profoundly affect every person, his leisure activities, and his intellectual and artistic development. Unlike television...the UIS will give each person maximum freedom of choice and will require individual activity. But the true historic role of the UIS will be to break down the barriers to the exchange of information among countries and people."* (A. Sakharov, Saturday Review/ World, 24 August 1974.)

Many, but not all, aspects of Sakharov's vision of the future have come to pass. Recent events demonstrate how access to disruptive technologies and communication networks can catalyze changes that can drive political systems out of equilibrium. The challenge, again illustrated by recent events, is to arrive at a new stable political equilibrium that respects individual liberties and human rights.

In his work as a scientist, Sakharov recognized the importance of out-of-equilibrium conditions in the early Universe. The next section takes this concept into the human arena, by considering the role of disruptive technologies in driving social and governmental systems out of equilibrium. Case studies are provided by recent events in both North Africa and Hong Kong. Access to evolving technologies and unfettered global information exchange are increasingly seen as fundamental civil liberties. Consequently emerging technologies are playing a crucial role in the ever-evolving scope of what we consider basic human rights.

Disruptive Technology and Socio-Political Equilibrium

There is an extensive social science literature that considers the application of the concepts of equilibrium [2] and "punctuated equilibrium" [3] in the context of governmental and social systems. The basic idea is illustrated in Figure 1. This is a notional figure where the vertical axis is some measure of instability, such as non-democratic governmental changes per decade. Situations that are socially and politically stable are indicated in blue, and unstable circumstances as red.

In this formulation, social and governmental systems can settle into one of a number of long-term-stable configurations, but can be driven out of equilibrium if disrupted, or if one or more the driving factors (economic, cultural, or political) change over time. Looking at the diversity of governments around the world, one can surmise that there are numerous equilibrium systems of governance, including dictatorships, monarchies, one-party governments, and a spectrum of implementations of democracy.

Western democracies aspire to maintain an equilibrium situation in which their citizens are economically secure, where individual rights are protected by the state, and where freedom of expression and freedom of religion are combined with an orderly and democratic change-over in representational government. But this circumstance currently eludes many of the countries on the face of the Earth, some of which are experiencing extended periods out of equilibrium.
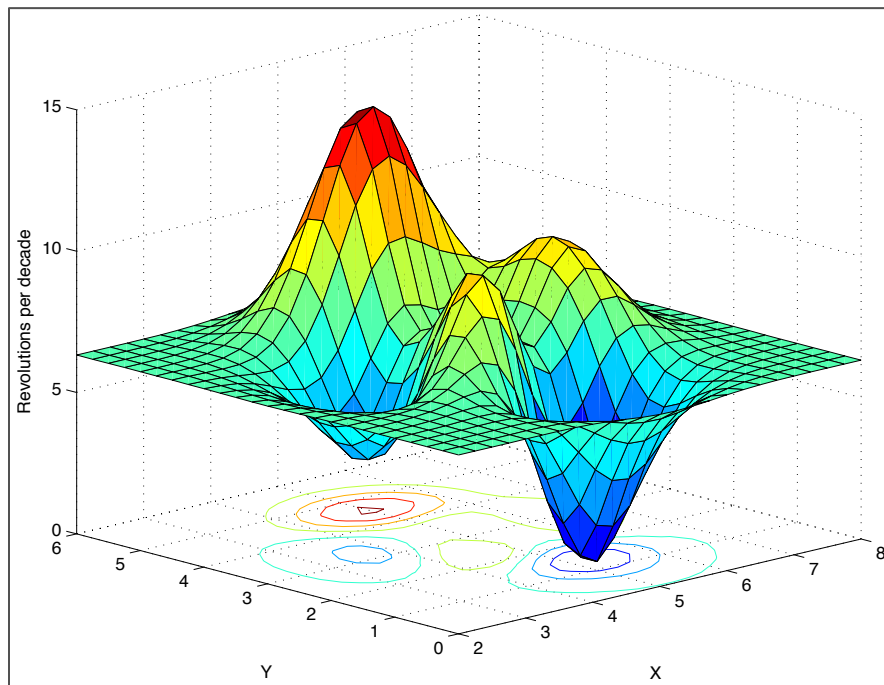

Figure 1. A Notional Social Equilibrium Surface. This notional diagram illustrates the concept social and governmental equilibrium. The vertical axis might be the rate of revolutionary governmental change, per decade, while X might represent the annual growth percentage in GDP and Y the number of political parties.

Figure 1 is meant to convey the notion of societies "settling into" stable equilibrium configurations that are shown as the upward-concave blue regions. But a sufficiently large disruption can push the system into an unstable situation, which will eventually result in a new equilibrium condition. This section will consider the role of personal technology access in driving major social and governmental change. We will use two recent examples: The Arab Spring uprisings and the ongoing (at this writing) pro-democracy demonstrations in Hong Kong.

Various authors have explored [4,5] the role that technology, connectivity, and social media played in North Africa during the 2010-2012 "Arab Spring" political upheavals. One school of thought holds that the speed at which public expressions of dissent and (in the cases of Tunisia, Egypt, Libya and Yemen) regime change occurred is directly attributable to the "political feedback" due to interactions occurring over social media. Another point of view [6] holds that the role of social media has been exaggerated, and that long-standing internal tensions simply boiled over in rapid succession.

There is little doubt, however, of how technology and connectivity by seen by the governments that were under pressure. In both Egypt and Libya the governments that were clinging to power took rather clumsy steps [7] to suppress their citizen's access to Internet communications. So these governments certainly perceived a threat arising from social media and from information transfer over the Internet. Their response was a heavy-handed attempt to cut off domestic Internet connectivity. But since the Internet was designed to be robust, with resilience against dropouts in one or more links, during the Arab Spring the citizens established and exploited connection pathways that sidestepped the government-controlled (and government-suppressed) information links.

A second example of modern technology playing a central role in public dissent is the 2014 pro-democracy movement in Hong Kong. Images of the crowds, such as Figure 2, show thousands of people waving their phones in the air, which is particularly apt given the rapidly evolving technological arms race between the demonstrators and their government. Gatherings were initially organized using social media tools [8]. The next step in the technical confrontation was an attempt (attributed [9] by many to the Chinese Government) to entice people to download a virus-like application onto their smartphones, that provided access to stored personal data on the phone. The protestors then in turn adapted by shifting to a direct phone-to-phone communication scheme (using the Bluetooth protocol) that entirely circumvents the government-controlled cell phone and Internet systems, thereby sidestepping the "Great Firewall of China".

In both the Arab Spring and Hong Kong examples, the governmental apparatus perceived the combination of dissent and technology to be sufficiently threatening that steps were taken to suppress, disrupt, or manipulate internal communications and/or information exchange with the outside world. This response alone is evidence for the important role of technology and instantaneous communications in contemporary political struggles, in which people attempt to assert their rights and realize their aspirations.

Figure 2. This photo from the 2014 pro-democracy movement in Hong Kong illustrates the interplay between technology and political aspirations. From http://www.newyorker.com/tech/elements/social-media-hong-kong-protests.

There are also equilibrium (or perhaps meta-stable equilibrium?) nation-states that routinely limit their citizen's access to information. A particularly dynamic situation at present is the Islamic Republic of Iran, which recently established a Supreme Council for Cyberspace [10], while simultaneously slightly relaxing the restrictions placed on social media access. In the framework of Figure 1, this is an attempt by the government to retain equilibrium (and power) by addressing the changing expectations among its populace with adjustments in its technology policy. China also exerts a tight control over information access by and between its citizens. Web sites are blacklisted by the tens of thousands [11], and as many as 16% of the postings on social media sites are deleted by censors [12].

The moves and counter-moves in cyberspace taken by governments and their citizens is a dynamic situation. The marketplace penetration of smartphones is a critical factor that determines their political impact. There is a steady increase in individual access to technology; according to one market analysis [13], by 2017 we can expect 69% of the world's population to own a mobile phone, and at that point half of these devices are expected to be "smartphones" with web connectivity, the ability to run applications, and exchange text messages and photographs. Access to this technology is rapidly increasing, along with the role it plays in our lives. The impact of this technology in disruptive political situations can only increase, until we reach the saturation point where phone-mediated information can rapidly reach the majority of people, either directly or through people around them who have phones.

<u>Is Technology Access a Basic Human Right?</u>

The consensus view of the scope of human rights and individual liberty evolves. Slavery is now unthinkable, and same-sex marriage is gaining increasing acceptance across the United States. Technology has the ability to impact virtually all aspects of our lives; parenting, education, commerce and finance, and entertainment are components of modern life that are undergoing fundamental changes that are driven by evolving technology. It is therefore no surprise that the nexus between technology, individual freedom of expression, and human rights is also changing.

Article 19 of UN Universal Declaration of Human Rights [14] asserts that

> *Everyone has the right to freedom of opinion and expression; this right includes freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers.*

Should this be interpreted as a guarantee of access to any Internet site by any individual? Does technology access constitute a human right, or simply a framework for freedom of expression? These questions are presently unresolved. This is an area of current public discourse [15], with one faction arguing in favor of a broad interpretation of Article 19. Others maintain that technology-mediated information access can *empower* human rights but is not such a right unto itself.

We are not yet, and may never be, at the point where individual technology access is a universally recognized human right. But there seems no doubt that we are witnessing a rapid evolution in the relationships between individuals, their governments, and personal-scale information technology. Individual access to information technology is increasing rapidly. This is driven by choices made by people who evidently highly value smartphone-mediated access to information, to banking services [16], and to one another. The role of social media in disruptive political events has demonstrably increased even in the short time between the Arab Spring uprisings of a few years ago and today's demonstrations in Hong Kong.

<u>The Sakharov Conditions, and Equilibrium in the Early Universe</u>

As we gather to honor Andrei Sakharov's legacy in human rights and in arms control, we should also pause and recognize his scientific accomplishments. This piece therefore closes with a brief summary of Sakharov's scientific insight into why the Universe has the properties we observe.

Cosmologists attempt to understand the contents and structure of the Universe, within a framework of fundamental physics. One basic goal of cosmology is to understand the ingredients of the cosmos. All of our observations are consistent with the idea that the Universe started in a dense hot state, from which it expanded and cooled. As the Universe cooled, it cascaded through the energy domains we associate with particle physics, to nuclear physics, to atomic physics, to astrophysics. One of the triumphs of the big bang model is the precise agreement between nuclear physics calculations and the observations of the relative abundances of light primordial elements (hydrogen, helium and lithium).

To place Sakharov's cosmology work in context, we need to quickly review the concept of anti-matter. Every elementary particle in nature has a twin anti-particle. We can routinely create matched pairs of protons and anti-protons, electrons and anti-electrons, neutrons and anti-neutrons in accelerators like the one here at SLAC. These anti-particles have electrical charges that are the opposite of their regular-matter partners, but identical masses. Antiprotons carry an electrical charge that is equal and opposite to the positive charge carried by protons, for example.

But in the freezing out of "substance" from the initially superheated primordial plasma, something strange must have happened. The simplest scenario would predict equal amounts of matter and anti-matter, produced in matching pairs. But when we look out at the Milky Way galaxy and beyond, we see no evidence for any primordial anti-matter at all. Anywhere. The simplest scenario is therefore clearly wrong.

The overwhelming cosmic preponderance of matter over anti-matter is a real mystery. Given the apparent intrinsic symmetry between matter and anti-matter, what could prompt the preference for one over the other? Andrei Sakharov took up this intellectual challenge. In 1967 he published a paper [17] that set forth three conditions (known throughout the cosmology community as the "Sakharov Conditions") that, if satisfied, would lead to a preference for matter over anti-matter in the evolution of the Universe.

One might think that simply breaking the matter-antimatter symmetry in some fundamental process would suffice, but Sakharov taught us that it takes more than that.
The "Sakharov conditions" for producing an excess of matter over antimatter are[1]:

1) The existence of an interaction or process that somehow intrinsically favors protons over anti-protons,

2) Two fundamental symmetries that physicists once thought sacrosanct[2] must be invalid, and

3) There must be an episode during which these processes are occurring out of thermal equilibrium.

These "Sakharov Conditions" for producing a cosmic matter-antimatter asymmetry are a cornerstone of modern cosmology. His 1967 paper has received over 1000 citations to date, and continues to frame our thinking about how the big bang could have cooked up the ingredients of our Universe. This lasting scientific legacy is an enduring testament to Sakharov's scientific intellect and insight, in addition to his well-deserved status as a champion of human rights and democratic values.

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[1] I have taken the liberty of attempting a phrasing that favors clarity for non-specialists over technical physics accuracy.
[2] These are charge conjugation, C, which flips the sign of all quantum numbers such as electrical charge and baryon number, and the product CP where P is parity reversal, essentially a spatial reflection. For many years these were long taken for granted as valid symmetries of Nature, but they aren't.

Closing Thoughts

Sakharov highlighted the pivotal importance of out-of-equilibrium processes in accounting for the prevalence of matter over antimatter in the Universe. This out-of-equilibrium concept can serve as a framework for considering the interplay between disruptive technologies, the structure of nation states, and our evolving view of human rights and individual freedoms.

Acknowledgements

References

[1] A. Sakharov, "*Tomorrow: the View from Red Square*", Saturday Review/World, Aug 24, 1974.

[2] see for example: Fararo, T. *"General Social Equilibrium: Toward Theoretical Synthesis", Sociological Theory"*, **11**, 3, p 291.

[3] see for example: Somit, A. and Peterson, S. "*The Dynamics of Evolution: The Punctuated Equilibrium Debate in the Natural and Social Sciences",* Cornell University Press (1992).

[4] Howard, P. N. et al, "*Opening Closed Regimes: What Was the Role of Social Media During the Arab Spring*?", from http://pitpi.org/wp-content/uploads/2013/02/2011_Howard-Duffy-Freelon-Hussain-Mari-Mazaid_pITPI.pdf

[5] Black, G., "*The Arab Spring and the Impact of Social Media*", from http://www.albanyassociates.com/notebook/2012/03/the-arab-spring-and-the-impact-of-social-media/

[6] http://www.telegraph.co.uk/culture/books/ways-with-words/8629294/Ways-With-Words-role-of-Twitter-and-Facebook-in-Arab-Spring-uprising-overstated-says-Hisham-Matar.html

[7] Dainotti, A. et al., "*Analysis of Country-wide Internet Outages Caused by Censorship*", from http://www.caida.org/publications/papers/2011/outages_censorship/outages_censorship.pdf

[8] Parker, E. "*Social Media and the Hong Kong Protests", New Yorker online,* Oct 1 2014*,* at http://www.newyorker.com/tech/elements/social-media-hong-kong-protests

[9] Mozur, P. "*Protesters in Hong Kong Are Targets of Scrutiny Through Their Phones",* New York Times, Oct 1 2014, at

http://www.nytimes.com/2014/10/02/business/protesters-are-targets-of-scrutiny-through-their-phones.html?_r=0

[10] http://www.nytimes.com/2013/09/17/world/middleeast/iran-facebook-twitter-access.html?_r=0

[11] Zittrain, B. and Edelman, B., "*Empirical Analysis of Internet Filtering in China",* *http://cyber.law.harvard.edu/filtering/china/* *(2006).*

[12] Bamman, D., O'Connor, B., Smith, N., "*Censorship and Deletion Practices in Chinese Social Media*", First Monday, **17**, (2012). http://journals.uic.edu/ojs/index.php/fm/article/view/3943/3169

[13] *"Smartphone Users Worldwide Will Total 1.75 Billion in 2014"* http://www.emarketer.com/Article/Smartphone-Users-Worldwide-Will-Total-175-Billion-2014/1010536 (2014)

[14] http://www.un.org/en/documents/udhr/index.shtml

[15] http://en.wikipedia.org/wiki/Right_to_Internet_access

[16] *"Mobile Money Revolution Aids Kenya's Poor, Economy",* NPR*,* http://www.npr.org/2011/01/05/132679772/mobile-money-revolution-aids-kenyas-poor-economy

[17] A. Sakharov, "*Violation of CP Invariance, C Asymmetry, and Baryon Asymmetry of the Universe*", Journal of Experimental and Theoretical Physics (JETP), **5**, 24 (1967).