Nuclear Weapons: Sources of Strength or Vulnerability?

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Aron M. Bernstein
Physics Dept., Lab for Nuclear Science MIT
“Some say nuclear disarmament is utopian, premature, a dream. say the illusion is that nuclear weapons provide security” UN Secretary-General Ban Ki-moon. Seoul, Oct. 2012

- Current dangers, pathways to nuclear war?
- nuclear weapons, Hiroshima, atomic scientists
- Force deployment; deterrence, war by accident?
- NPT, Iran Agreement, N. Korea
- Maintenance/modernization
- Outlook- citizen education, participation
Why think about nuclear weapons?

- Not used since 1945 - Hiroshima and Nagasaki (nuclear taboo)
- No danger since 1991 - Soviet Union collapsed.
- Deterrence works (peace through strength) “If you want peace prepare for war” (Roman)
- Let's work on more important issues like climate change....

Dangers are increasing Bulletin of Atomic Scientists “Doomsday Clock” reset to Cold War era levels

Cold war legacy: concepts, weapons, deployment modes
- US, Russia have 900 weapons ready to fire tension increasing Ukraine, Crimea, Syria modernizing weapons, delivery systems arms race
- Proliferation: India, Pakistan, N. Korea
Nuclear Weapons Education Initiative

Participate in education, public discourse

• Give a few lectures in undergraduate courses
• Could be part of a modern physics, science, history, politics, course
• Give a focused course on nuclear weapons (preferably interdisciplinary)
• Objective, factual, discussion of the issues
• This is not a call to politicize the classroom
• It is a call for creativity and moral responsibility
• Informal network of interested faculty members/students
• Students can request courses/information from the faculty
How do weapons work?

Critical Mass $\approx 10 \text{kgm} \quad ^{235}\text{U}, \approx 6 \text{kgm} \quad ^{239}\text{Pu}$

$> 2$ neutrons per fission
Nuclear Weapons Physics: order of magnitude estimate

fissionable material $^{235}U$, $^{239}Pu$

completely fission 1 kg -> 20kTon explosion blast lasts ~ 1 u sec temperature > interior of sun

critical mass
15 Kg (U), 5Kg (Pu)
• Hiroshima Aug. 6, 1945 15kTons ~ 2% efficient ≈35% killed, ½ first day, blast, burns, radiation Modern bombs are ≥ 10 times more powerful

• high altitude bomb-EMP could destroy all US electronics

one bomb, one city, many bombs - nuclear winter
We Meant so Well

Rabi at Los Alamos on the 40\textsuperscript{th} anniversary of Trinity

- First we were afraid that Hitler would get the bomb
- Then we were afraid that we would get it

Debate: Utility of Nuclear Weapons

**Pro**

- Ended war in Japan
- Saved casualties in WW2
- Prevented (deterred) WW3 US/USSR

**Con**

- Not necessary; were the first step in the cold war
- Needlessly killed Japanese civilians
- European war was not likely without nuclear weapons
Expectations about the bomb: 1945

- Atomic Scientists (Oppenheimer, Bohr, Franck, Szilard) so terrifying that war could be ended
- Genocidal weapons
- **Common problem that mankind should solve together**
  - no secret, no monopoly, no defense
  - international control required One World or None
- Politicians (Churchill, Roosevelt, Stalin,) a powerful tool to influence (coerce) others
  - neither was fully correct
- Small coercive influence during US monopoly (45-49) USSR took over Poland, Czechoslovakia
  - China entered the Korean War
- After NPT (1970)
  - deterrence, abhorrence □ non-use (nuclear taboo)
Number of warheads cold war
Estimated Global Nuclear Warhead Inventories, 2016

N. Korea ~5-10

Note: North Korea has produced fissile material for 10-12 warheads and detonated 4
test assemblies, but we're not aware of
public information that shows it has yet
stockpiled weaponized warheads.
Do we need to improve our nuclear arsenal?

**US Trident II Submarine**

- 24 missiles x 4 = 96 warheads
- could destroy that many targets
- warheads; 100kT, 475kT (Hiroshima ~15kT)
- delivery time 15-30 min
- total explosive power > 10MT
- total allied bombing in WWII ~ 3 MT
- could cause worldwide nuclear cooling, famine
- US 14 subs, England 4 (12+2 at sea)

**Can Nuclear War Happen?**

not rationally- no country wants it but tense situations can get out of control remainder of talk

will focus on this
Launch on Warning: accidental nuclear war?

- US and Russia have ~ 900 missiles on alert status
- Delivery times ~15 (30) min SLBM (ICBM) based
- Decision times ~ 10 min
- First strike capability
- False alarm (cyber?) -> mutual destruction global nuclear winter for ~ decade
- US president has nuclear black box 24-7
- Probability of error not negligible (complex systems)
- Each side vulnerable to the other’s system
- Russian early warning system less robust
- Need public education, pressure to change
Other Possible Pathways to Nuclear War

- Escalation of a conventional war
- Pakistan and India have ~ 100 weapons worldwide, causing a nuclear winter for several years.

- North Korea
  - 5 nuclear weapons tests, developing delivery missiles threaten to use them—could get out of control

- Complacency: nuclear weapons will never be used” no urgency to solve problem
Luck has saved us on many occasions

- 1962 Cuban Missile Crisis - Soviet nuclear submarine commander did not fire his nuclear weapons.
- US false alarm Nov. 1979 warning of 200 Soviet missiles on their way
- 1983 a false alarm in the Soviet early warning system indicated a US missile attack; Soviet officer on duty did not report this to his superiors, preventing a nuclear war; similar incident on US side 1983-L. Perroots
- Many incidents - nuclear weapons dropped by accident-did not detonate (Schlosser- Command and Control)
- Hacking of early warning system?

- Do nuclear weapons provide security or endanger it?
Nuclear Weapons Maintenance

- Last US test 1992 (No. 1132)
- 1994 Science Based Los Alamos Stockpile Stewardship maintains weapons without exploding them: experiments test components, supercomputers model weapons
- Enhanced safety, reliability
- Life extension, annual assessment

Modernization [arms race-decreased security?]

- 30 to 50 year plans to modernize all strategic delivery systems
- New Start level—although Pentagon certified 1/3 reduction OK
- Cost ~ $18b/y 2021 to 2035 in FY 2016 dollars, increase of ~3% to 7% of military budget
- Total cost of ~ $1T over the next 30 years ($90 million/day)
- Improved accuracy: B61-12 bomb (bombers), improved fuzing
Initiation of nuclear war

“Nuclear Button”
National Security State

- Set up 1947; cold war,
- Atom bomb required quick action

- Daily presidential security briefing
  Obama participated, not Trump

- Effect on president’s policy?
Nuclear Non-Proliferation Treaty (NPT) 1970

- 189 countries
- P5: US, Russia, China, England, France committed to disarm; no time schedule: article 6
- Resolution to ban nuclear weapons-UN
- **Iran**: 2015 agreement
- **Outside treaty**: India, Pakistan, Israel
- **N.Korea**: joined, withdrew: 5 tests
N. Korea serious problem, not a crisis

**Permanent war footing,** spends ~25% of GNP on military army 1.1 Million
~ 15%

Seoul -1.1 million people
-35 miles from N. Korea - ~13,000 artilleries.
Their Korean war 1950-53, armistice, no peace treaty

5 nuclear weapons tests
- First (2009) ~0.5kT detected international monitoring stations
- 2 in 2016
- Accelerated ballistic missiles program (26 in 2016).
- Violation of UN Security Council resolutions.

Obama policy “strategic patience”- sanctions waited for N. Korea to change course, did not work-sanctions evaded, capabilities increasing

Trump policy: get China to solve problem, threaten force direct diplomacy

needed: carrots and sticks
start with freeze
Negotiations with N. Korea, Zigs and Zags

• N. Korea signs NPT 1985. safeguards started in 1992 serious problems emerged with IAEA

• Agreed framework 1994-2002; N. Korea shut down its reactor, to be replaced mutual accusations of not carrying it out

• Jan. 2003: N. Korea withdraws from NPT

• First bomb test 2006 ≈ 0.5 kT (fizzle?) detected CTBT negotiations in 2008, 9 didn’t succeed

• US regarded agreement as freezing weapons development,

• N. Korea wanted diplomatic recognition, normalization and aid
N. Korea background information

- China does not want a failed nuclear weapons state on their border. 90% of the trade that North Korea has is with China.
- US THAAD (Terminal High Altitude Area Defense) missile deployment - problem with China.
- N. Korea made recent overtures - ignored.
- "Reckless Leader Nuclear Strategy Theory" (Thomas Schelling) leader cannot be counted on not to initiate nuclear war.
- Nixon-Kissinger tried this to end Vietnam War secret operation Giant Lance, Oct. 10, 1969 - placed U.S. nuclear assets on high alert bomber squadron with nuclear weapons flew patterns near USSR. didn’t work and was terminated.

- What happens when 2 leader try the same tactic??
- Kim Jong-un has been threatening to use nuclear weapons for years Trump – deterrence through threats "all options are on the table"
Key Restrictions Will Last Well Over a Decade

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<tr>
<th>Implementation begins</th>
<th>5 years</th>
<th>10 years</th>
<th>15 years</th>
<th>20 years</th>
<th>25 years</th>
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<tr>
<td>Implementation of additional protocol, commitment not to reprocess plutonium, NPT obligations</td>
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<td>Continuous surveillance of uranium mines and mills</td>
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<td>Continuous surveillance of centrifuge production areas</td>
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<td>LEU stockpile capped at 300 kg, no enrichment at Fordow, no new heavy-water reactors</td>
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<td>Limit of 5,060 IR-1 operating centrifuges</td>
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<td>Very limited R&amp;D on advanced centrifuges</td>
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- Blocks $^{239}\text{Pu}$ path to bomb (need $\approx 4\text{Kg}$)
  - unfinished Arak reactor reconfigured: $6\text{ Kg Pu/y} \rightarrow 1\text{ Kg/y}$ no weapons-grade plutonium, ship all spent fuel (Permanent)
- No additional heavy water reactors, will not reprocess fuel-15 years.
- but US policies preventing taking full advantage of this opportunity
Obama’s Nuclear Weapons Legacy?

- April 2009 Prague speech – abolish nuclear weapons
- **New Start Treaty (Feb. 2011)** - agreed to modernize arsenal
- **Improved Nuclear Security (Summits)**
- *Tried to engage Russia in further steps (failed)*
- **Iran agreement (2015)**
- ~1000 nuclear weapons still on launch on warning (US, Russia)
- **N. Korea**
- *Did not declare a no first use policy*
- *Did not get the CTBT(Comprehensive Test Ban Treaty) ratified*
Outlook; some reasons for guarded optimism

• No nuclear war since 1945 deterrence, nuclear taboo, luck
• Despite strains, NPT working reasonably well
• CTBO in operation: detected ~0.5kT N.Korean test
• Budget constraints in Russia and US may lead to nuclear force reductions
• Worldwide discussion of zero nuclear weapons
• Humanitarian renunciation of nuclear weapons (UN general assembly)
• Public education, opinion counts!
Plenty of Work to Reduce Danger of Nuclear War

- Take weapons off hair trigger alert
- Iran agreement - follow through, don’t scrap it!
- N. Korea - negotiations, not threats, involve China
- US-Russia - reduce weapons to ~1000 including tactical,
  - Stockpile stewardship program (maintain, not modernize)
  - Use budget constraints to improve nuclear weapons policy
    - Make NPT more effective prod US-Russia for reduction timetable
    - US discretionary budget > 50% military

- Scientists/academics: nuclear weapons education
- We need help with education project
Discretionary Spending 2015: $1.11 Trillion

- Military: $598.5 billion - 54%
- ~ $600 Billion > next 7 countries
Will Trump rip up the Iran agreement as he promised during the election campaign? “the stupidest deal of all time”

It is not just a US-Iran agreement the rest of the rest of the 5+ 1 want to keep it they are lifting sanctions and doing business

James Mattis, nominee for defense secretary
NYT, Dec. 2 ”Despite his tough stance on Iran.. he thinks that tearing up the agreement is favors keeping the agreement would hurt the US and favors working with allies to enforce its terms”.
