## Off

#### Interpretation – The affirmative can only garner offense from the appropriation of outer space by private entities being unjust. To clarify, no garnering offense off of methods to solve private entities appropriating outer space such as treaties or actor action.

#### Violation – They use the Public Trust Doctrine and solve impacts using its implementation

#### Standards:

#### 1] Limits – Only our interp accurately sets the upper limit to the topic. The CI will let the aff garner offense from any possible way to reduce property rights/private appropriation, which can range from treaties like OST, PTD, Common Heritage or state/actor action, which there are hundreds of. 0% chance the neg can prep for all possible offense relating to space possible and forces random LARP generics, killing fairness.

#### 2] Strat-Skew – Open ended interpretations that allow public companies to appropriate literally anything in space leads to infinite 1ACs. Forces the negative to allows fall back onto generics that can never have the potential to engage with affirmative on a content level. Aff gets everything while the neg is left with breadcrumbs. Kills fairness since the neg is always on the backfoot and no edu as we read backfile generics and try to outtech.

#### Voters -

#### 1] Education – 2-month time limit on the topic means every round is valuable. Specific education about the direct question the resolution asks is the only take away we get from this event. Precision in what they aff can read forces concise topic research in a limited area that allows us to deeply explore every area of the topic.

#### 2] Fairness – Fairness controls engagement with the 1AC and what we are actually able to do in the round. If the game stops becoming fair we have no reason to play in the first place. If every round was 80/20 skewed towards the aff then no one would ever be able to play the game. Fairness is key to clash and is an internal link into any of their offense

#### Paradigms -

#### Extra T is drop the debater – We indict your ability to read and garner offense from the affirmative in the first place. DTA on this shell means drop the aff as a whole anyway. The more the aff drops offense to meet the shell the less they solve and you can vote on presumption.

#### Competing interps over reasonability – Reasonability is always arbitrary and can never set a Brightline on what is reasonable and what isn’t. Extra T is a question of models not specific affirmatives or rounds.

#### No RVIs on Extra T –

#### 1] Extra T is a gateway issue for the negative towards the affirmative. Affirmative is always proactive towards topicality while the neg is forced to always be reactive towards the affirmative. The ground is skewed because we always have to hyper tailor T args to the affirmative while the aff can infinitely prep out the 6 T shells on the Topic

#### 2] Illogical – You don’t get to win for following the rules. That’s like me getting to win because I didn’t read 8 condo positions

#### Extra T outweighs 1AR theory –

#### 1] Extra T is a forced reaction to untopical affs, even if we did something wrong, you drew first blood. Any abuse from the negative is predicated by abuse from the affirmative.

## K:

#### Reading Curry is black fem-phobic – I’m gonna attach a shit ton of screen-shots and insert sections of curry’s work.

#### He scapegoats Black women as the ones who wanted Black men to be the patriarch – in response to Black hypermasculinity, Curry would blame Black women.

Curry 17 — Tommy J. Curry, Professor of Philosophy at Texas A&M University, holds a Ph.D. in Philosophy from Southern Illinois University, 2017 (“Conclusion: Not MAN but Not Some Nothing,” *The Man-Not: Race, Class, Genre, and the Dilemmas of Black Manhood*, Published by Temple University Press, ISBN 9781439914878, p. kindle 4854-4996)

Intersectionality and Hegemonic Masculinity

While contemporary intersectionality theorists argue that the theory can and, in fact, does apply to Black males, there has been no critical interrogation of the role dominance theory plays in explaining or defining heterosexual Black male behavior under intersectionality. For example, Frank Rudy Cooper’s “Against Bipolar Black Masculinity: Intersectionality, Assimilation, Identity Performance, and Hierarchy” asserts that the analysis of Black male bipolarity (the oscillation between the Good Black and Bad Black male image) “is an intersectional phenomenon because it is the product of the combination of narratives about [B]lackness in general and narratives about [B]lack masculinity in particular.”36 At the same time, however, he asserts that heterosexual Black men, good and bad, are seduced “into taking pleasure in the present hierarchies”37 Despite their material location, in prison or in the boardroom, “heterosexual [B]lack men are taught to emulate the economically-empowered heterosexual white men who set the norms in this culture.”38 Using Michael Kimmel’s essay “Masculinity as Homophobia,” Cooper interprets Raewyn Connell’s theory of hegemonic masculinity to conclude:

The predominant account of normative United States masculinity describes it as fundamentally based on a fear of being associated with denigrated others. To be a full man, one must distinguish oneself from femininity. One accomplishes that by distancing himself from the qualities associated with women and from women themselves. Instead, one treats women as possessions to be displayed as evidence of one’s manhood. Similarly, one must distance oneself from gay men. This is the attempted repudiation of the presence of feminine qualities in men.39

Kimmel cites Connell’s Gender and Power to explain hegemonic masculinity as “the image of masculinity of those men who hold power.” 40 According to Kimmel, “We equate manhood with being strong, successful, capable, reliable, in control.”41 In fact, it is these definitions of manhood that are used to “maintain the power that some men have over other men and that men have over women.” As discussed previously, these notions simply do not apply to racially subordinated males who are targeted by white patriarchy. As decades of data have suggested, Black men and boys simply do not see masculinity either as the ideal for which one should strive or as synonymous with Black manhood.

Cooper argues that heterosexual Black men seek to emulate this normative white masculinity, making them “feel compelled to prove their manhood through acts that distance them from marginalized others.” Perhaps most interesting, he maintains that intersectional disadvantage does not change the impulse of the heterosexual male. Despite their condition or circumstances, “heterosexual [B]lack men will seek to offset their feelings of powerlessness by subordinating others.”42 This explanation highlights the difference between the application of a theory and anthropological assumptions behind a theory. Cooper argues that intersectionality helps us understand the identity-level tensions and conflicts between Black men being designated as good or bad in a white-supremacist society, but behind the analysis of identity is an assumption about the nature of heterosexual Black men. Cooper’s claim does not emerge from any historical or empirical study of heterosexual Black males, but from the familiarity this narrative has among gender theorists—his repetition of the consensus concerning Black males held by his audience. Cooper only cites the anecdotal analysis bell hooks offers of Black males’ political aspirations after emancipation. While hooks admits that newly freed Black men and women were both struggling with the contradictions of gender in which Black women demanded that Black men protect and provide for them, it is only Black men, in their struggle to fulfill this role and be recognized as men, who are deemed patriarchs.43 Like Michele Wallace, hooks is unable to conceptualize (non-feminist-inspired) Black masculinities, especially after racial integration.44 She assumes that the history of Black gender relations can be told as one that conceptualizes Black womanhood as participating in sexism but is much less innocuous in its reproduction of patriarchy than Black males, while the political struggles of Black men are primarily mimetic and motivated by their desire to dominate others. Since hooks provides no citations to substantiate her interpretation of (heterosexual) Black men’s 150-year struggle for freedom in this country, the reader is expected to accept Cooper’s understanding of the Black male personality based solely on the authoritative force of bell hooks’s pronouncement. Regardless of their location, heterosexual Black men, because they are male, are thought always to aspire to the characteristics of white (bourgeois) masculinity. Even in those cases where the Black male is shown to be materially oppressed, Cooper asserts, Black males will subordinate others to compensate for the power they lack.

#### AND He argues that women have privilege in the court system, and they actively use and exploit it in assault cases.

Curry 17 — Tommy J. Curry, Professor of Philosophy at Texas A&M University, holds a Ph.D. in Philosophy from Southern Illinois University, 2017 (“Introduction: Toward a Genre Study of Black Male Death and Dying,” *The Man-Not: Race, Class, Genre, and the Dilemmas of Black Manhood*, Published by Temple University Press, ISBN 9781439914878, p. kindle 705-823)

Black Male Vulnerability as a Foundation: Evaluating the Political Economy of Black Male Erasures from Theory

Black male vulnerability is the term I use to capture the disadvantages that Black males endure compared with other groups; the erasure of Black males’ actual lived experience from theory; and the violence and death Black males suffer in society. The term is not meant simply to express the material disadvantages Black males face due to incarceration, unemployment, police brutality, homicide, domestic and sexual abuse throughout society, or their victimhood. The term is also meant to express the vulnerable condition—the sheer fungibility—of the Black male as a living terror able to be killed, raped, or dehumanized at any moment, given the disposition of those who encounter him. Black male vulnerability is an attempt to capture the Black male’s perpetual susceptibility to the will of others, how he has no resistance to the imposition of others’ fears and anxieties on him. Despite the contemporary intersectional, feminist, and liberal-progressive framings of gender hierarchies that maintain that Black men have some privilege based on their maleness, Black men and boys lag behind on practically every population indicator, from education and income to health and mortality.

Classrooms are hostile environments for young Black boys.105 They are often thought of as lazy, disruptive, and in need of the most discipline.106 Teachers routinely assert that Black boys are less intelligent than whites and Black girls and treat them less favorably as a result.107 Some scholars have even shown that parents have taken up the view that Black boys are less academically gifted than Black girls. These lower parental expectations for Black boys academically leads to not only less parental involvement in their education but also less reward or encouragement for their academic success.108 The negative experiences Black boys endure from kindergarten through twelfth grade have very real consequences for college and beyond. Since the dawn of the twenty-first century, Black men have received fewer than 40 percent of the associate, professional, and doctoral degrees awarded to Black Americans.109 The consequence of Black males earning fewer bachelor’s and doctoral degrees is reflected in the number of Black male professors at Title IV institutions throughout the country. According to the most recent report by the American Association of University Professors, there are roughly 48,000 Black male and about 70,000 Black female professors at Title IV colleges or universities in the United States.110 Black female professors outnumber Black male professors by a little more than 20,000. In contrast to the history of white Americans in higher education, Black men have always been outnumbered by their female counterparts in college enrollment and degree attainment. As the demographer Anne McDaniel explains, “The historical trend in college completion for [B]lacks is not marked by the reversal of a gender gap that once favored males, as it is for whites, but rather entails a longstanding female advantage.”111

Similarly, the economist Rhonda Sharpe notes, “Since 2000, Black women earned twice as many associate’s, bachelor’s and master’s degrees as [B]lack men and nearly twice as many professional and doctorate degrees.”112 The growth of Black women in the university has allowed them, as a group, to attain tenure-track employment at rates comparable that of their non-Black counterparts over the past two decades,113 while Black males are still trying to gain sustainable access to colleges and universities at the baccalaureate level.114 This historical advantage of Black women in education, first remarked on by W.E.B. DuBois in 1927, brings attention to a stark race-sex inequality disregarded by many, if not most, scholars working on race and gender.115 If this gender gap in education continues, warns Wilma Henry, “by 2097, all of the baccalaureate degrees earned by African Americans will be bestowed on African American women.”116 The smaller number of Black males pursuing college as a first choice drives many into labor-intensive blue-collar occupations. While these jobs will offer some economic independence compared with those years spent in college, Black males in these blue-collar occupations rarely climb the economic ladder into the middle class. This lack of class mobility for Black males carries the risk of poverty and unemployment.

Incarceration has also had a devastating impact on Black males’ lifelong economic prospects. At the end of 2009, an estimated 841,000 Black men and 64,800 Black women were in state or federal prisons and local jails.117 According to the Bureau of Justice report on prisoners, “On December 31, 2014, [B]lack males had higher imprisonment rates than prisoners of other races or Hispanic origin within every age group.”118 The economists Derek Neal and Armin Rick found that “the growth of incarceration rates among [B]lack men in recent decades combined with the sharp drop in [B]lack employment rates during the Great Recession have left most [B]lack men in a position relative to white men that is really no better than the position they occupied only a few years after the Civil Rights Act of 1965.”119 The impact of incarceration is not simply rooted in the removal of these Black males from society. Incarceration also marks Black men for years after they are released, making employment and basic sustenance nearly impossible. Evelyn Patterson and Christopher Wildeman’s recent study “Mass Imprisonment and the Life Course Revisited” found that imprisonment has even more devastating effects on Black males’ economic condition and quality of life than previously thought, since incarceration robs Black males of disproportionately more years that they are capable of working. Patterson and Wildeman conclude, “The total amount of time [B]lack men on average spend marked—not in prison but an ex-prisoner and felon—is far larger (at 11.14 years, corresponding to roughly 27 percent of their working lives). . . . [T]his means that [B]lack men spend on average 31 percent—roughly one-third—of their working lives either locked in a state prison or struggling to overcome the negative outcomes that result from their marked status.”120 As Becky Pettit argues, “High rates of incarceration among [B]lack men—and [B]lack men with low levels of education in particular—have profound implications for accounts of their social standing and that of their children, families, and communities where they live prior to and following incarceration.”121 Incarceration, then, is more than simply an institution; it is a socially invigorated stigma that marks poor, uneducated Black males throughout their lives and is far too often related to their impending deaths. But what if society is so dangerous for Black men and boys that prison, despite its deleterious consequences, is preferable? Evelyn Patterson’s “Incarcerating Death: Mortality in U.S. State Correctional Facilities, 1985–1998,” points out that Black men are actually safer in prison than in American society. She writes, “For [B]lack males at every age, death rates were higher for the population outside of prison compared with their same-race counterparts in prison.”122 What are scholars to make of this paradoxical social reality?

Historically, the prison has been explained as an institution that deprives the criminal of freedom. Incarceration is thereby linked to slavery and America’s history of racism by the extent to which Black men are criminalized and then made into prisoners, but rarely do these analyses explore the sexual aspects of imprisonment. As with our notions of racism, and even American slavery, Black males are imagined only in terms of their confrontation with white male power, never in terms of their vulnerability to rape or sexual violence at the hands of white men and women. Regardless of race, we live in a culture that denies the vulnerability of men to rape generally. Rape, when it does happen to men, is thought to be perpetrated only by other men. Women are never thought of as rapists or as perpetrators of sexual violence. As Lara Stemple, Andrew Flores, and Ilan Meyer explain, “Stereotypes about women, which reflect gender and heterosexist biases, include the notion that women are nurturing, submissive help mates to men. The idea that women can be sexually manipulative, dominant, and even violent runs counter to these stereotypes. Yet studies have documented female perpetrated acts that span a wide spectrum of sexual abuse, which include even severe harms such as nonconsensual oral sex, vaginal and anal penetration with a finger or object, and intercourse.”123 Female perpetration of sexual violence does not occur in a vacuum. Female perpetrators are aware of the innocence attributed to femininity and consequently the protection being female offers them from being seen as perpetrators of sexual violence, especially in cases involving imprisoned Black males.

#### AND He Misgenders queer folx

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#### AND Says Black Trans folx are too small of a category to analyze the intersections between transness and violence

Graphical user interface, text, application

Description automatically generated

#### And Elitist –

Graphical user interface, text, application, chat or text message

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#### AND Positions Black males as the Most oppressed in society – pathologizing the plights of black women

Text

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#### AND Silences Black Women

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#### That’s a reason to DTD: 1.] DTA makes it a no risk option – they can always read the argument and then go for it if a team doesn’t call them out but if they are they kick out of it. Only rejecting them sets a norm of violent authros to read. 2.] Risk of reading this author causes trauma to other debaters in the future is proof of why you should err on the side of dropping the team 3.] Even if they cited a different portion of curry, we shouldn’t let him gain academic hegemony that invisiblizes his violent tendencies

#### This is a procedural thing that comes far before we evaluate content

## Case

### Debris

**1] Probability – 0.1 percent chance of a collision.**

Alexander William **Salter**, **Economics Professor at Texas Tech**, **’16**, “SPACE DEBRIS: A LAW AND ECONOMICS ANALYSIS OF THE ORBITAL COMMONS” 19 STAN. TECH. L. REV. 221 \*numbers replaced with English words

The probability of a collision is currently **low**. Bradley and Wein estimate that the **maximum probability** in LEO of a collision over the lifetime of a spacecraft remains **below one in one thousand**, conditional on continued compliance with NASA’s deorbiting guidelines.3 However, the possibility of a future “snowballing” effect, whereby debris collides with other objects, further congesting orbit space, remains a significant concern.4 Levin and Carroll estimate the average immediate destruction of wealth created by a collision to be approximately $30 million, with an additional $200 million in damages to all currently existing space assets from the debris created by the initial collision.5 The expected value of destroyed wealth because of collisions, currently small because of the low probability of a collision, can quickly become significant if future collisions result in runaway debris growth.

**2] Time frame – Kessler effect 200 years away.**

Peter **Stubbe**, PhD in law @ Johann Wolfgang Goethe University Frankfurt, **’17**, State Accountability for Space Debris: A Legal Study of Responsibility for Polluting the Space Environment and Liability for Damage Caused by Space Debris, Koninklijke Brill Publishing, ISBN 978-90-04-31407-8, p. 27-31

The prediction of possible scenarios of the future evolution of the debris p o p ulation involves many uncertainties. Long-term forecasting means the prediction of the evolution of the future debris environment in time periods of decades or even centuries. Predictions are based on models84 that work with certain assumptions, and altering these parameters significantly influences the outcomes of the predictions. Assumptions on the future space traffic and on the initial object environment are particularly critical to the results of modeling efforts.85 A well-known pattern for the evolution of the debris population is the so-called Kessler effect’, which assumes that there is a certain collision probability among space objects because many satellites operate in similar orbital regions. These collisions create fragments, and thus additional objects in the respective orbits, which in turn enhances the risk of further collisions. Consequently, the number of objects and collisions increases exponentially and eventually results in the formation of a self-sustaining debris belt around the Earth. While it has long been assumed that such a process of collisional cascading is likely to occur only in a very long-term perspective (meaning a time 1 n of several hundred years),87 a consensus has evolved in recent years that an uncontrolled growth of the debris population in certain altitudes could become reality much sooner.88 In fact, a recent cooperative study undertaken by various space agencies in the scope of i a d c shows that the current l e o debris population is unstable, even if current mitigation measures are applied. The study concludes:

Even with a 90% implementation of the commonly-adopted mitigation measures [...] the l e o debris population is expected to increase by an average of **30% in the next 200 years.** The population growth is primarily driven by catastrophic collisions between 700 and 1000 km altitudes and such collisions are likely to occur every 5 to 9 years.89

**3] Status quo solves – mitigation and remediation compliance growing.**

**Colombo et. al 18**—Camilla Colombo, PhD, visiting academic in Spacecraft Engineering within Engineering and Physical Sciences at the University of Southampton; Francesca Letizia, PhD, Space Debris Engineer at ESA Space Debris Office; Mirko Trisolini, PhD, Postdoctoral researcher at the Politecnico di Milano Department of Aerospace Engineering; Hugh Lewis, PhD, Professor within Engineering and Physical Sciences at the University of Southampton (“Space Debris: Risk Mitigation,” from Frontiers of Space Risk: Natural Cosmic Hazards & Societal Challenges, Chapter 5, p 128-136)

5.4 MITIGATION MEASURES The space debris problem is nowadays internationally recognized, therefore mitigation measures are being taken and guidelines discussed. These can be divided into two classes: The avoidance or protection measures and the active and passive debris removal measures. The avoidance or protection measures include the design of satellites to withstand impacts by small debris, or the selection of safe procedures for operational spacecraft such as orbits with less debris, specific attitude configurations, or implementing active avoidance maneuvers to avoid collisions. On the other hand, measures for debris removal currently consist in limiting the creation of new debris (by prevention of in-orbit explosions and ensuring spacecraft subsystems reliability), to free some orbital implementing end-of-life disposal maneuvers protected regions, or to reenter in the atmosphere. Active debris removal is also being considered as a mean to stabilize the growth of space debris by removing from orbit some selected noncompliant objects. The e.Deorbit mission will target an ESA-owned derelict satellite in low orbit, capture it with a net or robotic arm technology, and reenter with a controlled atmospheric reentry (Biesbroek et al. 2014). Acknowledging the fact that the projected growth in the number of satellites orbiting the Earth will increase in the future, space agencies and international organizations have been discussing and building a set of guidelines to ensure the sustainability of future space activities. The InterAgency Debris Coordination Committee (IADC) was founded in 1993 by ESA (Europe), NASA (the United States), the Japan Aerospace Exploration Agency (JAXA, Japan), and the Roscosmos Russian Federation. As of January 2017, the IADC also includes the Italian Space Agency (ASI, Italy), the Centre National d'Études Spatiales (CNES, France), the China National Space Administration (CNSA, China), the Canadian Space Agency (CSA, Canada), the German Aerospace Centre (DLR, Germany), the Korea Aerospace Research Institute (KARI, South Korea), the Indian Space Research Organisation (ISRO, India), the National Space Agency of Ukraine (NSAU, Ukraine), and the UK Space Agency (UKSA, United Kingdom). This international cooperation decided a set of space debris mitigation measures (Inter-Agency Space Debris Coordination Commitee, 2002), which includes: 1. Limitation of debris released during normal operations. 2. Minimization of the potential for on-orbit breakups (resulting from stored energy after the completion of mission operations, or during the operational phases of the mission and by avoiding intentional destruction and other harmful activities). 3. Post Mission Disposal in particular in geosynchronous regions and for objects passing through the LEO region. 4. Prevention of on-orbit collisions. The IADC guidelines were presented to the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS) and contributed to the creation of the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space to be considered for the mission planning, design, manufacture and operational phases of spacecraft and launch vehicle orbital stages” (United Nations Office for Outer Space Affairs 2010): 1. Limit debris released during normal operations. 2. Minimize the potential for breakups during operational phases. 3. Limit the probability of accidental collision in orbit. 4. Avoid intentional destruction and other harmful activities. 5. Minimize potential for post-mission breakups resulting from stored energy 6. Limit the long-term presence of spacecraft and launch vehicle orbital stages in the low Earth orbit region after the end of their mission. 7. Limit the long-term interference of spacecraft and launch vehicle orbital stages with the geosynchronous region after the end of their mission. 5.4.1 Mitigation Guidelines for Post Mission Disposal In this section we focus on the third of the measures dictated by the IADC, namely Post Mission Disposal. A “25-year rule” was defined to limit the presence of satellites in the LEO region to no more than 25 years after their decommissioning. The 25-year limit was selected to ensure that a reasonable reduction in lifetime could be achieved without greatly affecting satellite resources. After 25 years a satellite has to be removed from the LEO protected region by placing it in a graveyard orbit or by disposing of it through atmospheric reentry. According to the IADC Space Debris Mitigation Guidelines (Inter-Agency Space Debris Coordination Commitee 2002) if "a spacecraft or orbital stage is to be disposed of by re-entry into the atmosphere, debris that survives to reach the surface of the Earth should not pose an undue risk to people or property.” The low Earth orbit protected region (LEO region) is the spherical shell region that extends from the Earth's surface up to an altitude of 2000 km. The geosynchronous protected region (GEO region) is a segment of a spherical shell with a lower and upper altitude boundary of 200 km below and above the geostationary altitude of 35,786 km, and which is constrained by a latitude sector extending between plus and minus 15 degrees from south to north (Inter-Agency Space Debris Coordination Committee 2002; United Nations Office for Outer Space Affairs 2010). At altitudes below 600 kilometers, spacecraft with a conventional area-to-mass ratio (i.e., conventional satellites have a value of area-tomass ratio around 0.012 m?/kg) will reenter within a few years due to atmospheric drag. Intervention to remove and prevent further creation of debris above that altitude should therefore be the primary focus of passive mitigation measures. As described in the document on the “Requirements on Space Debris Mitigation for ESA Projects” (ESA 2008) and the "ESA Space Debris Mitigation Compliance Verification Guidelines” (ESA 2015), end-of-life measures can be distinguished in: (1) Disposal, (2) passivation, and (3) reentry. Required measures for disposal currently cover spacecraft in LEO and GEO through a series of Operational Requirements (OR) (ESA 2008): "OR-01. Space systems operating in the LEO protected region shall be disposed of by reentry into the Earth's atmosphere within 25 years after the end of the operational phase." "OR-02. Space systems operating in the GEO protected region shall be disposed of by permanently removing them from the GEO protected region.” The GEO disposal orbit should be almost circular (i.e., eccentricity less of equal to 0.005) and with a minimum perigee altitude above the geostationary altitude, which is given as a function of the solar radiation pressure coefficient of the space system at the beginning of its life and its cross-sectional area. This is done to take into account the eccentricity oscillation due to the effects of solar radiation pressure and to ensure that such oscillation would not make the orbit interfere with the GEO protected regions. "OR-03. Where practicable and economically feasible, space systems outside the LEO and GEO protected regions shall implement means of end-of-life orbit disposal to avoid long-term interference with operational orbit regions, such as the Galileo orbit." OR-04. Launcher stages shall also perform end-of-life disposal maneuvers by targeting "direct reentry as part of the launcher sequence.” Alternatively, they should be injected into a LEO orbit with a maximum reentry time of 25 years. As other space systems, they should be removed from LEO and GEO protecting region and orbit that interfere with other operational orbits such as the one of the Galileo orbit. OR-05. Passivation of the system (spacecraft or launcher stage) has to be completed within 2 months of the end of mission. End-of-life measures for reentry include: OR-06. "For space systems that are disposed of by reentry," an "analysis has to be performed to determine the characteristics of fragments surviving to ground impact, and assess the total casualty risk to the population on ground assuming an uncontrolled reentry.” OR-07. Such a casualty risk has to be lower than 10-4 if an uncontrolled reentry is targeted; otherwise if the casualty risk is higher than the threshold of 10-4, "a controlled reentry must be performed such that the impact footprint can be ensured over an ocean area, with sufficient clearance of landmasses and traffic routes." The rate of compliance of missions to the end-of-life mitigation guidelines was analyzed by the ESA Space Debris Office in 2017). Between 2006 and 2015, the rate of compliance of LEO missions (including naturally compliant missions and satellites performing end-of-life maneuvers) was 53.3% for the payloads (corresponding to 60.3% of the payload mass), reaching end of life in the LEO protected region (Frey and Lemmens 2017). The compliant objects, with a lifetime after decommissioning of less than 25 years, include naturally compliant objects due to their initial altitude well inside the Earth's atmosphere (this constitutes the biggest part of the compliant share), compliant objects after a deorbit maneuver, or spacecraft having performed a maneuver leading to a direct reentry. In terms of mass, this share is constantly sloping downward. Between 2007 and 2016, 71.6% of the rocket bodies reaching end of life in the LEO protected region was compliant, and this fraction has remained virtually unchanged for 8 years in a row despite an increase in end-of-life maneuver activity. 5.4.2 Passive End-of-Life Disposal In order to meet the mitigation guidelines LEO satellites at the end of their life would use the remaining propellant to perform either a perigeelowering maneuver (to decrease the orbit perigee well inside the Earth's atmosphere to guarantee a reentry within 25 years) or a direct reentry. Spacecraft in GEO are instead currently re-orbited to quasi circular orbits outside the GEO protected ring, with a perigee line aligned with the SunEarth direction (where possible) in order to bind the long-term oscillations in the eccentricity caused by solar radiation pressure. Recently, ESA funded projects on the design of disposal trajectories for medium Earth orbits (MEO) (Alessi et al. 2014; Rossi et al. 2015), highly elliptical orbits (HEO), and libration Earth orbits (LPO) (Armellin et al. 2014; Colombo et al. 2014; Colombo et al. 2015). These have demonstrated the possibility of exploiting natural orbit perturbations for designing passive mitigation strategies for debris disposal. Disposal strategies enhancing the effects of orbit perturbations have been further analyzed in LEO (Alessi et al. 2017), in MEO (Rosengren et al. 2015; Alessi et al. 2016; Armellin and San-Juan; Daquin et al. 2016; Gkolias et al. 2016), in GEO (Colombo and Gkolias 2017), and in HEO (Colombo et al. 2014; Armellin et al. 2015). Indeed, it was shown that, rather than performing an expensive maneuver to lower the perigee, the optimal maneuver should be given in a way to change the disposal orbit to another neighborhood orbit where the effect of orbit perturbations causes the orbit perigee to enter into the atmosphere. Indeed, the effects of luni-solar perturbation causes long-term oscillation on the eccentricity, which can be exploited so that the spacecraft's trajectory over a long period (from 5 to 70 years, depending on the initial orbit) could lead to natural reentry. This effect can be enhanced by solar radiation pressure, especially if considering a spacecraft equipped with large solar panels or a deployable reflective surface (Lücking et al. 2012, 2013). Moreover, resonances with the Earth's nonuniform potential can enhance the eccentricity growth effects. 5.4.2.1 An Example of End-of-Life Deorbiting Exploiting Luni-Solar Perturbations One of the most beautiful demonstrations of how natural dynamics can be enhanced is given by the INTEGRAL mission designed by ESA, the United States, Russia, the Czech Republic, and Poland. The INTErnational Gamma-Ray Astrophysics Laboratory, launched in 2002, gathered some of the most energetic radiation from space (Eismont et al. 2003). A reentry of this spacecraft with a pure impulsive maneuver would have not been possible due to the limited amount of propellant left onboard. In an ESA-funded study, the end-of-life disposal of INTEGRAL mission--expected to end in 2016-was designed with a time window for disposal between January 1, 2013 and January 1, 2029. Reentry solutions with a delta-velocity requirement below 40-50 m/s were found (Colombo et al. 2014). The main perturbations acting on the dynamics of the reentry were luni-solar perturbations, which affect the evolution of eccentricity, inclination, and anomaly of the perigee measured with respect to the Earth-Moon plane. It was shown that depending on the set of initial elements, which depends on the date the reentry maneuver is performed, the proposed maneuver would then aim at further increasing or decreasing the eccentricity. In particular, if we focus on the natural evolution of the eccentricity under luni-solar perturbation and Earth's oblateness, when the nominal eccentricity is low, the optimal reentry maneuver further decrease the eccentricity value; as a consequence, the following long-term propagation will reach a higher eccentricity, corresponding to a reentry. In this case, the maneuver is more efficient (i.e., lower delta velocity is required) (Colombo et al. 2014). Once the initial disposal maneuver is performed, the spacecraft evolves under natural perturbations and the reentry can then be semicontrolled. The high inclination of HEOs represents an advantage as the final reentry phase can target regions at higher latitudes on the Earth's surface thereby reducing the ground hazard. In the case of HEOs, reentry is caused by luni-solar perturbation (not air drag), therefore the orbit reenter with quite a high eccentricity (high apogee and low perigee) and does not circularize. Due to the oscillations in eccentricity, the next optimal window for injecting the spacecraft into a reentry trajectory is between 2013 and the first half of 2018 for a final reentry in 2028. After that, the required maneuver would increase until reaching a next window for performing the maneuver between the second half of 2021 and the first half of 2026, for a reentry in 2028. These analytical studies were used for high fidelity parametric analyses performed by the ESA (Merz et al. 2015) to investigate the effect of a maneuver at apogee to change the perigee altitude. The final maneuver sequence was given at the beginning of 2015 and split into three major burns plus a touch-up for final fine-tuning. The spacecraft is now on its course to reentry in 2028 (see Figure 5.11).

### Radiation

#### Climate change causes extinction

Ruiter 17 Zach Ruiter 17, environmental reporter for Now Toronto and Torontoist, citing 15, 364 scientists from 184 countries in ‘World Scientists’ Warning to Humanity: A Second Notice’, 11-22-17, “Are we headed for near-term human extinction?” https://nowtoronto.com/news/are-we-headed-for-near-term-human-extinction/

A “warning to humanity” raising the spectre “of potentially catastrophic climate change... from burning fossil fuels, deforestation and agricultural production – particularly from farming ruminants for meat consumption,” was published in the journal BioScience last week. More than 15,000 scientists from 184 countries endorsed the caution, which comes on the 25th anniversary of a letter released by the Union of Concerned Scientists in 1992, advising that “a great change in our stewardship of the earth and the life on it is required, if vast human misery is to be avoided.” A quarter century on, what gets lost in the dichotomy between climate change believers and deniers is that inaction and avoidance in our daily lives are forms of denial, too. And what most of us are collectively denying is the mounting evidence that points to a worst-case scenario unfolding of near-term human extinction. Exponential climate change In 2015, 195 countries signed the Paris Climate Agreement to limit the rise in global temperature to below 2 degrees Celsius to avoid dangerous climate change. But none of the major industrialized countries that signed the agreement are currently on track to meet the non-binding targets. The Trump administration has indicated the United States will withdraw from the agreement entirely. In July, a study in the peer-reviewed journal, Proceedings Of The National Academy Of Sciences Of The United States Of America, claimed “biological annihilation via the ongoing sixth mass extinction” is underway. And that “all signs point to ever more powerful assaults on biodiversity in the next two decades, painting a dismal picture of the future of life, including human life,” the study states. According to scientists, the majority of previous mass extinctions in the geologic record were characterized by abrupt warming between 6 to 7 degrees Celsius. As recently as 2009, British government scientists warned of a possible catastrophic 4 degrees Celsius global temperature increase by 2060. As Howard Lee wrote in the Guardian in August, “Geologically fast build-up of greenhouse gas linked to warming, rising sea-levels, widespread oxygen-starved ocean dead zones and ocean acidification are fairly consistent across the mass extinction events, and those same symptoms are happening today as a result of human-driven climate change.” Runaway climate change is non-linear. Shifts can be exponential, abrupt and massive due to climate change “feedbacks,” which can amplify and diminish the effects of climate change. Here are five you need to know about: 1. Climate lag Temperature increases lag by about a decade, according to NASA’s Earth Observatory. “Just as a speeding car can take some time to stop after the driver hits the brakes, the earth’s climate systems may take a while to reflect the change in its energy balance.” According to a NASA-led study released in July 2016, “Almost one-fifth of the global warming that has occurred in the past 150 years has been missed by historical records due to quirks in how temperatures were recorded.” Adding the climate lag to the current level of global temperature increase would take us past the 2-degree Paris Agreement climate target within a decade. 2. Ice-free Arcti Dr. Peter Wadhams of the Polar Ocean Physics Group at Cambridge University told The Independent more than a year ago that the central part of the Arctic and the North Pole could be ice-free within one to two years. Not only will melting Arctic sea ice raise global sea levels, it will also allow the earth to absorb more heat from the sun because ice reflects the sun’s rays while blue open water absorbs it. One study in the Proceedings Of The National Academy Of Sciences Of The United States Of America estimates the extra heat absorbed by the dark waters of the Arctic in summer would add the equivalent of another 25 per cent to global greenhouse gas emissions. 3. The 50 gigaton methane “burp” Dr. Natalia Shakhova, of the University of Alaska Fairbanks’ International Arctic Research Center has warned that a 50-gigaton burp, or “pulse,” of methane from thawing Arctic permafrost beneath the East Siberian Arctic Shelf is “highly possible at any time.” Methane is a greenhouse gas much more potent than carbon dioxide. A 50 gigaton burp would be the equivalent of roughly two-thirds of the total carbon dioxide released since the beginning of the industrial era. 4. Accelerated ocean acidification The world’s oceans are carbon sinks that sequester a third of the carbon dioxide released into the atmosphere. The carbon dioxide emitted in addition to that which is produced naturally has changed the chemistry of seawater. The carbon in the oceans converts into carbonic acid, which lowers pH levels and makes the water acidic. As of 2010, the global population of phytoplankton, the microscopic organisms that form the basis of the ocean’s food web, has fallen by about 40 per cent since 1950. Phytoplankton also absorb carbon dioxide and produce half of the world’s oxygen output. The accelerating loss of ocean biodiversity and continued overfishing may result in a collapse of all species of wild seafood by 2048, according to a 2006 study published in the journal Science. 5. From global warming to global dimming The Canadian government recently announced plans to phase out coal-fired electricity generation by 2030. But at the same time as warming the planet, pollution from coal power plants, airplanes and other sources of industrial soot, aerosols and sulfates are artificially cooling the planet by filling the atmosphere with reflective particles, a process known as global dimming. Airplanes, for example, release condensation trails (or contrails) that form cloud cover that reflects the sun. The effects of global dimming are best evidenced by a 2 degree Celsius temperature increase in North America after all commercial flights were grounded for three days following the attacks of 9/11. The take-away Out of control climate change means feedback mechanisms may accelerate beyond any capacity of human control. The occurrences discussed in this article are five of some 60 known weather-related phenomenon, which can lead to what climate scientist James Hansen has termed the “Venus Syndrome,” where oceans would boil and the surface temperature of earth could reach 462 degrees Celsius. Along the way humans could expect to die in resource wars, starvation due to food systems collapse or lethal heat exposure. Given all that remains unknown and what is at stake with climate change, is it irresponsible to rule out the possibility of human extinction in the coming decades or sooner?

#### Grossman 96 assumes slow death from cancers, not a nuclear wipeout. Also literally no studies or ev is explained, just highlighted buzznumbers.

#### The Nuclear weapons dropped on Japan were *WAY* more than the 1 pound limit set by the aff in Grossman 96 – if we win that these high levels of radiation were good then that certainly means 1 pound of plutonium equally spread over the world would not kill us all. (1kg = 2.2 lbs)

Wellerstein 13 Kilotons per kilogram by Alex Wellerstein, published December 23rd, 2013 <http://blog.nuclearsecrecy.com/2013/12/23/kilotons-per-kilogram/> Alex Wellerstein is a historian of science and nuclear weapons and a professor at the Stevens Institute of Technology. He is also the creator of the NUKEMAP.This blog began in 2011. For more, follow @wellerstein. //avery

The Fat Man bomb had a much better use of fissile material than Little Boy. Its yield wasn’t that much better (around 20 kilotons), but it managed to squeeze that (literally) out of only 6.2 kilograms of plutonium-239. Pu-239 releases around 19 kilotons per kilogram that completely fissions, so that means that around 15% of the Fat Man core (a little under 1 kg of plutonium) underwent fission. But the bomb itself still weighed 4,700 kg, making its yield-to-weight ratio a mere 0.004 kt/kg. Why, despite the improve efficiency and more advanced design of Fat Man, was the yield ratio almost identical to Little Boy? Because in order to get that 1 kg of fissioning, it required a very heavy apparatus. The explosive lenses weighed something like 2,400 kilograms just by themselves. The depleted uranium tamper that held the core together and reflected neutrons added another 120 kilograms. The aluminum sphere that held the whole apparatus together weighed 520 kilograms. The ballistic case (a necessary thing for any actual weapon!) weighed another 1,400 kg or so. All of these things were necessary to make the bomb either work, or be a droppable bomb

#### Their authors engage in data supression

Adams 12 – Rod Adams, “ Radiation Protection Profession – Hiding Health Benefits of Low Level Radiation (aka Hormesis),” ATOMIC INSIGHTS, 8-22-12. http://atomicinsights.com/2012/08/radiation-protection-profession-hiding-health-benefits-of-low-level-radiation.html. LAP

It’s time to knock off that destructive behavior. Its only function is to protect persons who believe their job depends on scaring people. Radiation protection is an honorable function, and done right, it can help us find ways to operate more profitably, not less. But we in the nuclear community have continually bad-mouthed ourselves and our profession. It’s time to stop it. There is a vast body of good scientific evidence that in the dose range of interest, more radiation is beneficial. But a great deal of effort has gone into hiding that fact. The relevant policy-setting reports like NCRP-136 and -121 concede that the data demonstrate hormesis, but they recommend it would be “prudent” to assume the opposite. It’s not science, but a strange sense of prudence, that leads people to want to hide hormesis. As James Muckerheide documented years ago, “There Has Never Been a Time That the Benefits of Low-Dose Ionizing Radiation Were Not Known.” T.D. Luckey’s canonical works on Radiation Hormesis in 1980 and 1991 documented some 3000 cases of hormesis. Sakamoto, Hattori and others have been healing people with half-body irradiation. The literature covered in the 2012 ANS President’s Special Plenary published a 200-page summary report on the subject. The most important news about the terrifying subject of nuclear radiation is that it’s good for you. When do we lift the ban on telling people that?

#### LNT is wrong and paid off by oil companies

Sutou 18 Sutou, S. Low-dose radiation from A-bombs elongated lifespan and reduced cancer mortality relative to un-irradiated individuals. Genes and Environ 40, 26 (2018). <https://doi.org/10.1186/s41021-018-0114-3> School of Pharmacy, Shujitsu University, 1-6-1 Nishigawara, Naka-Ku, Okayama-Shi, 703-8516, Japan //avery

Oil industries felt uneasy about nuclear energy and took over the National Academy of SciencesStandard Oil Co. Inc. was founded by John Rockefeller in 1870, who later established the Rockefeller Foundation (RF) in 1913. The oil industry might well have felt threatened by the discovery of atomic energy. The Republican Party had forged a close relationship with the oil industry, but the Democratic Party, led by F.D. Roosevelt (1933–1945) and H. Truman (1945–1953), governed the USA during and after WWII. When Republicans were reelected, Nelson Rockefeller was appointed as an important aide to President Eisenhower. Muller, in turn, had close ties to the RF. In 1954, the RF chose to finance a large project to evaluate ionizing radiation. RF asked the U.S. National Academy of Sciences (NAS) to organize the program, which was conducted under the auspices of NAS President Bronk of Rockefeller University, also an RF trustee. The Genetics Panel (GP) of the NAS Biological Effects of Atomic Radiation (BEAR) committee was established in 1954 and was chaired by Weaver, a mathematician and director of RF. With no significant discussion, GP recommended LNT on June 12, 1956 [19]. The limit dose for nuclear workers of 500 mGy/y, which had been in place since 1934, was discarded. The next day, the front page of the New York Times, owned by an RF trustee, reported that radiation is dangerous. Other media followed suit. Soon, several leading biologists asked GP to provide documentation that supported LNT. GP refused to do so because they never possessed relevant data. This decision was cast, and reasonably so, as an ideologically motivated choice based on deliberate falsification and fabrication of research records [20]. Fossil fuel companies are opposed to nuclear energy even today.

#### Radiation from nuclear bombing prevents cancer and extends life.

Sutou 18 Sutou, S. Low-dose radiation from A-bombs elongated lifespan and reduced cancer mortality relative to un-irradiated individuals. Genes and Environ 40, 26 (2018). <https://doi.org/10.1186/s41021-018-0114-3> School of Pharmacy, Shujitsu University, 1-6-1 Nishigawara, Naka-Ku, Okayama-Shi, 703-8516, Japan //avery

The effects of black rain were studied using mortality data from 1950 to 2005 and cancer incidence data from 1958 to 2005 in Hiroshima and Nagasaki. The authors conclude that deleterious health effects from black rain exposure were not detected [28]. However, there is apparently a methodical fault. The authors asked people, “Was the person caught in Fallout Rain?” (Yes or No). According to the response, they were then divided into Yes or No groups. This grouping is almost meaningless because the important matter is not Yes or No, but if they had entered black rain affected areas within 2–3 weeks after detonation when residual materials remained active (Fig. 3). When solid cancer deaths and solid cancer incidence are extracted from the literature [28], excess relative risks (ERR) were smaller in the Yes group (caught in the rain) than in the No group (not caught in the rain) (Table 1). The data are suggestive of hormesis: slight radiation exposure is cancer-inhibitory.The black rain affected areas were so wide that almost all A-bomb survivors and NIC must have been irradiated to a greater or lesser degree by residual radiation. The UNSCEAR 1958 report describes that almost all leukemia patients in zone C (1500–1999 m from ground zero) complained of severe radiation sickness in spite of an estimated dose of 50 rem (500 mSv in the International System of Units (SI)). Their doses must have been greater than 50 rem [29]. Exposure of around 2 Gy (close to 2 Sv in SI) is necessary to induce severe radiation sickness.

#### Hormesis solves cancer, strengthens immune systems, and extend length of life

Taverne 04 Dick Taverne, 8-8-2004, "Nuclear power is fine," <span class="skimlinks-unlinked">Telegraph.co.uk</span>, <span class="skimlinks-unlinked">https://www.telegraph.co.uk/comment/personal-view/3609373/Nuclear-power-is-fine-radiation-is-good-for-you.html</span>

Unfortunately, far from safeguarding our health, current safety standards will almost certainly increase the incidence of cancer. The evidence shows that the effect of radiation on human health is not a linear one, but is a J-shaped curve. Exposure starts by being beneficial at low doses and only becomes harmful at higher doses. This effect is known as hormesis. A low dose of ionising radiation seems to stimulate DNA repair and the immune system, so providing a measure of protection against cancer. The benefit of low doses of radiation in treating cancer have been known for some time and are confirmed by a mass of evidence, particularly from Japan where it has been studied in detail as a result of Hiroshima and Nagasaki. Many other examples of the hormesis effect are well known. A bit of sunshine does you good; too much may cause skin cancer. Small doses of aspirin have many beneficial effects; too much will kill you. It also appears to apply to arsenic, cadmium, dioxins and residues of synthetic pesticides, but that is another story. Epidemiological evidence confirms the hormesis effect of radiation. The prediction that there would be terrible after-effects from the atomic bombs dropped on Hiroshima and Nagasaki on the survivors and their children was proved wrong. Japanese studies of the life expectancy of survivors who suffered relatively low amounts of radiation show that their life expectancy turned out to be higher than those of the control group and no unusual genetic defects have been found in their children. Again, a follow-up study of Japanese fishermen who were contaminated with plutonium after the nuclear tests at Bikini found 25 years later that none of them had died from cancer. After the Chernobyl disaster it was also predicted that the incidence of cancer among those affected by fallout would greatly increase and there would be huge genetic damage to future generations. It was about as bad an accident to a nuclear power station (a badly constructed one) as is likely to happen. Its psychological effect was huge and changed people's perception of the risk of nuclear energy all over the world. Indeed, it is constantly cited as an example of the unparalleled threat to health from nuclear disasters. Tragically, it led to 31 deaths, mainly among rescue workers who were exposed to very high doses of radiation. Yet in the areas around Chernobyl the extra radiation to which people were exposed in the nine years following the accident was slight - an increase of about 0.8- 1.4 mSv. In May 2001, in the Ukrainian town of Pripyat, which is now a ghost town after its complete evacuation, the average amount of persistent radiation found was 0.9 mSv a year, five times lower than the level in New York's Grand Central Station. In parts of southwest France the levels of natural radiation are as high as 870 mSv a year. There is strong evidence that people exposed to low doses of radiation - amounts 100 times more than the recommended range - actually benefit. The incidence of thyroid cancers among children under 15 exposed to fallout from Chernobyl was far lower than the normal incidence of thyroid cancer among Finnish children. The death rate from leukemia of nuclear industry workers in Canada is 68 per cent lower than average. Workers in nuclear shipyards and other nuclear establishments in the US and many other countries have substantially lower death rates from all cancers and are much less likely to die from leukemia. This might be explained by the fact that their health is regularly checked and that only healthy workers are employed. But it corresponds with a mass of other evidence that people who live in areas of unusually high natural radiation, in Japan, China, India and the US, are less likely to die from cancer than a control group. These facts destroy what are perhaps the strongest objections to nuclear power. They show that the regulations seeking to enforce present, let alone proposed, minimum standards of safety not only cost billions of pounds and have undermined the prospects of our development of nuclear power, but do more harm than good. It is time that we looked more closely at the phenomenon of hormesis and at the successful Japanese experience of using low-dose radiation to treat cancer. When the evidence is so clear, we should not allow it to be brushed aside by conventional wisdom and ignorance.

#### Hormesis solves nuclear terror

Solomon 12 – Lawrence Solomon, executive director of Energy Probe, “ Lawrence Solomon: Evacuation a worse killer than radiation,” ENERGY PROBE, 9-21-12. http://ep.probeinternational.org/2012/09/24/lawrence-solomon-evacuation-a-worse-killer-than-radiation/. umn-lap

Radiation hormesis, if accepted by the public and adopted by emergency-preparedness authorities, would not only reduce the size of evacuation areas, it would also be a wet blanket for terrorists. Their perennial goal of taking out a nuclear reactor would lose its appeal, as would detonating a dirty bomb — the radiation lacing the bomb could act to save lives down the road, making it less deadly than a conventional bomb and costing terrorists one of their preferred instruments of mayhem.

#### hormesis key to space colonization—the only barrier is high intensity radiation—meltdowns build up radiation-resistance, making colonization possible – Turns the aff

#### hormesis key to survivability of colonies

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In space biodosimetry, symmetrical exchanges (dicentrics and translocations) have been widely used, while the extremely low occurrence of complex-type exchanges (Durante et al., 2004) or intra-chromosomal exchanges (Horstmann et al., 2005) render these CAs of little use for risk estimates. 1004 M. Durante, L. Manti / Advances in Space Research 42 (2008) 999–1007Data have accumulated from space missions carried out over the past decade. When yields of dicentrics were measured pre- and post-ﬂight in 8 cosmonauts involved in short term ﬂights (<3 months) and 15 crewmembers of long-term Mir missions (>3 months), an increase was found in post- ﬂight dicentrics frequency, but this was signiﬁcant only in the case of long-term ﬂights (Durante et al., 2003). The ratio of post- to pre-ﬂight measured aberrations was then used to compute individual Excess Relative Risk (ERR) and a satisfactory agreement was obtained with ERR derived from physically measured dose (Durante, 2005). This implies that CA frequency measured shortly before and after a single long-term ﬂight allows sound risk estimate. For CAs to be a reliable biodosimetre in the event of prolonged sojourn in space, it is nevertheless essential to consider their dependence upon time. Hence, it matters whether dicentrics or translocations are examined because they diﬀer in their expected time decay. Half-time for decay of dicentrics and translocations is around 2 and 6 years, respectively (Durante, 2005; Obe et al., 1999). Furthermore, the current astronauts’ career limits are set assuming the additivity of the dose-dependent eﬀects of prolonged exposure. CA measurements in cosmonauts involved in multiple space missions represent the closest approximation to interplanetary missions scenario. No correlation was found between interchomosomal exchange frequency and total duration of missions or cumulative dose equivalent in space for 13 cosmonauts involved in multiple space ﬂights to Mir or the International Space Station (Durante et al., 2003). Also, it appeared that the postﬂight decline in time of dicentrics and translocations was faster than expected and strongly dependent upon the individual, with smaller increases in the aberration burden being induced after multiple missions compared to the ﬁrst one. As argued by Durante (2005), since CA frequency in lymphocytes reﬂects mutagenic burden and genomic instability at any time, CAs can be regarded as an individual risk assessment rather than an average, dose-based risk estimate, and hence their timedependent decline can be viewed as an individual-dependent change in the stochastic risk after the chronic, low-dose exposure. Another possibility is that an adaptive response to the space environment takes place after the ﬁrst exposure, which may confer the exposed individual an increased radioresistance. Such a response would be similar to that hypothesised to explain the apparent lack of adverse health eﬀects in VHBRA and HBRA residents. As pointed out by Mortazavi et al. (2003), radiobiological studies on these areas may lead to the identiﬁcation of the cellular and molecular mechanisms by which susceptibility to genetic damage and cancer is decreased by chronic radiation exposure, hence helping the astronaut selection process.

#### radiation-resistance is the biggest barrier

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The main long-term objective of the space exploration program is the colonization of the planets of the Solar System. The high cosmic radiation equivalent dose rate represents an inescapable problem for the safe establishment of permanent human settlements on these planets. The unshielded equivalent dose rate on Mars ranges between 100 and 200 mSv/year, depending on the Solar cycle and altitude, and can reach values as high as 360 mSv/year on the Moon. The average annual eﬀective dose on Earth is about 3 mSv, nearly 85% of which comes from natural background radiation, reduced to less than 1 mSv if man-made sources and the internal exposure to Rn daughters are excluded. However, some areas on Earth display anomalously high levels of background radiation, as is the case with thorium-rich monazite bearing sand deposits where values 200–400 times higher than the world average can be found. About 2% of the world’s population live above 3 km and receive a disproportionate 10% of the annual eﬀective collective dose due to cosmic radiation, with a net contribution to eﬀective dose by the neutron component which is 3–4 fold that at sea level. Thus far, epidemiological studies have failed to show any adverse health eﬀects in the populations living in these terrestrial high-background radiation areas (HBRA), which provide an unique opportunity to study the health implications of an environment that, as closely as possibly achievable on Earth, resembles the chronic exposure of future space colonists to higher-than-normal levels of ionizing radiation. Chromosomal aberrations in the peripheral blood lymphocytes from the HBRA residents have been measured in several studies because chromosomal damage represents an early biomarker of cancer risk. Similar cytogenetic studies have been recently performed in a cohort of astronauts involved in single or repeated space ﬂights over many years. The cytogenetic ﬁndings in populations exposed to high dose-rate background radiation on Earth or in space will be discussed

#### even if hormesis doesn’t solve—spurs research which allows effective shielding

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1. Introduction

The ambitious Vision for Space Exploration laid out by the National Aeronautics and Space Administration (NASA) sets the colonization of the planets of the Solar System as the next frontier for manned space exploration (NASA, 2004). Although naturally occurring radiation is the most persistent and ubiquitous DNA-damaging agent under which life has evolved on Earth, the radiation ﬁeld that space colonists will have to contend with is unprecedented: it consists of a mixture of protons, high-energy heavy ions and secondary particles resulting from nuclear fragmentation reactions with shielding materials (Benton and Benton, 2001). It is widely recognized that the main uncertainties attached to sound risk management and shielding optimization stem from the fact that the biological eﬀectiveness of the space radiation environment in the induction of cancer and degenerative diseases is essentially unknown (Cucinotta et al., 2004; Townsend, 2005; Cucinotta and Durante, 2006). Furthermore, while the terrestrial natural background radiation amounts to an average eﬀective dose rate of 2.4 mSv/year, to which about 0.4 mSv/ year must be added due to cosmic radiation at near sea level (UNSCEAR Report, 2000a), the mean daily absorbed dose for radiosensitive tissues known to be susceptible to cancer induction has been calculated as 0.42 mGy on Mars surface, which corresponds to an eﬀective dose of more than 1 Sv for a long-duration mission (Cucinotta et al., 2001). This is because of the lack of an intrinsic magnetic ﬁeld, which helps deﬂect cosmic radiation on Earth, and despite a degree of protection aﬀorded by the carbon dioxide atmosphere. Devoid of the thin Martian atmosphere, the Moon surface is exposed to dose rates ranging between 100 and 360 mSv/year (Horneck et al., 2001). In a scenario of Lunar or Martian colonisation, settlers will most likely incur yearly doses that are less than those given by these ﬁgures, since these do not take into account risk-modifying factors such as the age or gender of the exposed individual, or ameliorating countermeasures such as the type and material used for transportation or dwellings. Albeit crude, however, these values ought to be projected on a life-long time frame and will clearly exceed both the highest total equivalent dose reconstructed for previous space missions (Benton and Benton, 2001) and the astronauts’ career exposure limits as set by current space radioprotection guidelines for low-Earth orbit missions (NCRP, 2000).

#### Low level radiation now creates resiliency to high radiation in the future

**Wang et al 08** – Wang GJ, Li XK, Sakai K, Lu Cai, Department of Hematology and Oncology, The First University Hospital, Jilin University Medical College, “Low-dose radiation and its clinical implications: diabetes,” Hum Exp Toxicol. 2008 Feb;27(2):135-42.http://www.ncbi.nlm.nih.gov/pubmed/18480138

Induction of hormesis and adaptive response by low-dose radiation (LDR) has been extensively indicated. Adaptive response induced by LDR was not only resistant to damage caused by a subsequently high-dose radiation, but also cross-resistant to other non-radiation challenges, such as chemicals," investigators in Changchun, People's Republic of China report (see also Obesity and Diabetes Therapy).

"Mechanisms by which LDR induces the preventive effect on radiation-or chemical-induced tissue damage include induced or up-regulated expression of protective proteins, such as heat shock proteins and antioxidants. Since oxidative damage to tissues is a major pathogenesis of many human diseases including diabetes, this review will summarize the available data with an emphasis of the preventive effect of LDR on the development of diabetes and the therapeutic effect of LDR on diabetic cardiovascular complications. The available data indicated that pre-exposure of mice to LDR reduced the incidence of alloxan-induced diabetes, and also delayed the onset of hyperglycaemia in diabetes-prone non-obese diabetic mice. Experiments with animals indicated the effectively therapeutic effect of low-intensity or power laser (LIL or LPL) radiation on skin wound healing, which has stimulated clinical use of LIL to cure skin ulcer in diabetic patients. Mechanisms by which LDR prevents diabetes, though are unclear now, may include the induction of pancreatic antioxidants to prevent beta cell from oxidative damage and immunomodulation to preserve pancreatic function. For LIL therapeutic effect on diabetic wound healing, mechanisms may include its antioxidant action, immunomodulation, cell proliferation stimulation as well as improvement of systemic and wound-regional microcirculation. Therefore, although only a few studies indicating LDR prevention of the development of diabetes, many studies have demonstrated LDR, specifically LIL, therapeutic effectiveness of diabetic wound healing.