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Experiences of modernity in the greenhouse: A cultural analysis of a physicist "trio" supporting the backlash against global warming

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Abstract

This paper identifies cultural and historical dimensions that structure US climate science politics. It explores why a key subset of scientists—the physicist founders and leaders of the influential George C. Marshall Institute—chose to lend their scientific authority to this movement which continues to powerfully shape US climate policy. The paper suggests that these physicists joined the environmental backlash to stem changing tides in science and society, and to defend their preferred understandings of science, modernity, and of themselves as a physicist elite—understandings challenged by on-going transformations encapsulated by the widespread concern about human-induced climate change.

Keywords: Anti-environmental movement; Human dimensions research; Climate change; Controversy; United States; George C. Marshall Institute

1. Introduction

Human Dimensions Research in the area of global environmental change tends to integrate a limited conceptualization of culture. It commonly conceives of it as just one factor among others, a non-pervasive factor separate from central social processes associated with environmental change, including scientific understanding. However, a growing area of scholarship stresses the need to also study the role of culture and politics in the very production of scientific knowledge and associated adjudications (see, among many, Fischer, 2003; Jasanoff and Wynne, 1998; Jasanoff and Long Martello, 2004; Lahsen, 1999, 2005a, 2007; Rayner and Malone, 1998; Shapin and Schaffer, 1985; van der Sluijs et al., 1998; Wynne, 1994). Such research continues to be scarce in the area of Human Dimensions Research focused on global environmental change, despite efforts to change this fact. In a 1998 article in this journal, Proctor (1998) argued in favor of a conceptualization of culture as a pervasive factor structuring also scientific understanding of global environmental change itself, what he termed a "strong theory of culture." Arguing that the essential role of science in our present age only can be fully understood through examination of individuals' relationships with each other and with "meanings sedimented in institutions and other perennial forms" (ibid.), Proctor concluded the article by commenting on the importance of considering how cultural contradictions and experiences of modernity relate to global environmental change:

> One crucial object of human dimensions inquiry thus ought to be the differentiated condition and experience of modernity […]. Modernity is full of cultural contradictions—the professed mastery of nature juxtaposed against the burgeoning environmental movement, for example. How do these contradictions influence and respond to global environmental change, and what future implications exist? (p. 243)

Nearly 10 years later, analyses of climate science controversy still tend to ignore its deeper socio-cultural roots and the extent to which it involves a debate about wider social values, as also recently noted by the founding

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director of the UK Tyndall Centre for Climate Change Research (Hulme, 2007).

Integrating a strong theory of culture and attending to experiences of modernity, this article highlights socio-cultural and political dimensions underpinning divisions among US scientists on the issue of human-induced climate change. Informed by ethnographic research among US climate scientists from the period 1994–2000, it analyzes the involvement of an influential group of physicists in light of their personal and professional backgrounds. It explains these physicists' engagement with the backlash as a response to broader social transformations with which they, in many respects, are at odds—transformations in understandings of the interrelationships between nature, society, science, and technology. It portrays their attitudinal inclinations and understandings of techno-scientific risks in terms of cultural factors, including, among other things, their professional socialization among nuclear physicists and their important and prestigious roles as science-policy advisors.

Since the late 1980s, scientists have fueled public fears that humans might be dangerously interfering with global climate patterns. A series of assessment reports produced under the auspices of the United Nations Intergovernmental Panel on Climate Change (IPCC) (1990, 2001, 2005, 2007) have helped consolidate these fears by concluding that a continuation of present global greenhouse gas emissions trends threatens ecological and social systems worldwide. The success of scientists and environmentalists in raising concern about the issue provoked an "anti-environmental" backlash in the US, advanced by an influential, interconnected network of industry representatives, conservative political groups, politicians, and sympathetic scientists aversive to climate policy action (Brown, 1996; Gelbspan, 1995, 1997; Lahsen, 1999, 2005a; McCright and Dunlap, 2003; Rowell, 1996; Stevens, 1993).[1] This network of "backlash actors" challenges scientific evidence supporting the theory of anthropogenic warming and attacks the objectivity and procedural integrity of the IPCC (Lahsen, 1999; Edwards and Schneider, 2001). Backlash actors claim that "sound science" does not support the theory of human-induced climate change, and suggest that human emissions of greenhouse gases benefit rather than harm nature and humans (Robinson and Robinson, 1997). Furthermore, the coalition of backlash actors claims that internationally binding climate policy is unnecessary, unreasonable, overly expensive, and destructive of US economic competitiveness in the world economy (see, among many examples, Michaels, 1992; Robinson and Robinson, 1997; Seitz, 1996; Science and Environmental Policy Project, 1992; Singer, 2003).[2]

Despite indications that "an overwhelming majority of the US public embraces the idea that global warming is a real problem that requires action,"[3] US policy action has lagged (Sarewitz and Pielke, 2000), in part because of the powerful efforts of the backlash coalition. Democrats and Republicans alike have contributed to the gridlock that has undermined preventive national climate policy, but Republicans have been particularly vehement in their opposition to the Kyoto Protocol in particular, and to preventive policy on the issue in general. Throughout the 1990s, Congressional Republicans gave backlash views important play in Congressional hearings (Brown, 1996; Gelbspan, 1997; Lahsen, 1999). Republican opposition to preventive policy action on the climate issue culminated in President W. Bush's rejection of the Kyoto Protocol soon after entering office (March 2000), citing scientific uncertainties and economic imperatives. The continued skepticism among members of Congress, and in particular among Republicans, was also established by a recent survey. Asked whether they believed it to have been "proven beyond a reasonable doubt that the Earth is warming because of man-made pollution," only 23% of Republicans answered in the affirmative, by contrast to 98% of the Democrats.[4] Yet other evidence of the continued impact of contrarian arguments can be found in a 2003 Congressional report prepared for Congressman Henry Waxman,[5] a 2004 report by the Union of Concerned Scientists,[6] books such as Chris Mooney's *Republican War on Science* (2005) and popular magazines such as *Newsweek* (Begley, 2007), and in scholars' analyses in academic journals (e.g., Jacques, 2006; Krosnick et al., 2006; Leiserowitz, 2006; McCright and Dunlap, 2003; Oreskes, 2005). A 2005 peer-reviewed study of US media coverage (Antilla, 2005) identified a large amount of articles which framed climate change in terms of debate, controversy, or uncertainty. It found some major news outlets to repeatedly favor and rely on climate skeptics for definitions of the science and dangers related to human-induced climate change. Recent surveys found that most Americans lack "vivid, concrete, and personally-relevant affective images of climate change" (Leiserowitz, 2006, p. 55) and that the US public as a whole is less concerned about the issue compared to the scientific establishment (Krosnick et al., 2006). The studies link the US public's lower sense of urgency to the relatively low

[1] Following Austin (2002), I define "antienvironmentalism" as a collection of ideologies and political practices designed to advance capital accumulation and manage the discontents stemming from industrial production and mass consumption.

[2] See McCright and Dunlap's (2000) analysis and description of the counter-claims made by the conservative movement regarding global warming.

[3] The two 1998 polls were conducted by the Program on International Policy Attitudes (PIPA), which researches public attitudes on international issues by conducting nationwide polls, focus groups and comprehensive reviews of polling conducted by other organizations. PIPA is a joint program of the Center on Policy Attitudes (COPA) and the Center for International and Security Studies at Maryland (CISSM), School of Public Affairs, University of Maryland.

[4] Congressional Insiders Poll, National Journal, 1 April 2006, accessible at: http://www.envsci.rutgers.edu/~weaver/national_journal_2006_04_01_insiders.pdf.

[5] http://democrats.reform.house.gov/features/politics_and_science/pdfs/pdf_politics_and_science_rep.pdf.

[6] www.ucsusa.org/scientific_integrity/interference/reports-scientific-integrity-in-policy-making.html.

priority enjoyed by the issue on the national agenda (Leiserowitz, 2006, p. 55) and suggest that skeptical news coverage may be an important factor in this (Krosnick et al., 2006) American.

Aaron McCright and Dunlap (2003) identify the conservative movement as a central obstacle to US policy proposals concerning human-induced climate change, and examine how a small group of "dissident" or "contrarian" scientists lent crucial scientific credentials and authority to conservative think tanks. McCright and Dunlap (2000) analyze the discourses structuring the contrarian scientists' counter-claims related to climate change and how conservative think tanks have mobilized these claims to undermine concern about climate change. Carvalho (2007) found that the American skeptics also have featured prominently in the British "quality press" in support of a neoliberal, capitalist agenda.

The above-mentioned sociological work on the anti-environmental movement establishes the *what* and the *how* dimensions of scientists' engagement with it. What it does not illuminate is *why* such scientists have chosen to lend their support to this movement: Who are they? Where do they come from? What motivates them? This paper seeks to answer these questions with regards to three influential physicists who joined the backlash, Frederick Seitz, Robert Jastrow, and William Nierenberg (hereafter referred to as "the trio").

The trio is a subgroup within the dozen or so high-profile US scientists who have been staunch and public in voicing their criticisms of environmental concern about human-induced climate change and associated policy action. The contrarians represent numerous disciplines and vary also in terms of other factors (age, home institutions, status) etc. but about half of them are physicists.[7] This study discusses the sociological significance of this strong representation of physicists among the contrarians, but without drawing conclusions about physicists as a whole.

Little social scientific work has probed the role of history and belief-structures in shaping scientists' positions on climate change. This is partly because scientists' role in policy has tended to be perceived in terms of "speaking truth to power" (Collingridge and Reeve, 1986), obscuring the role of politics in science and obviating the need for critical scrutiny of science and scientists as also cultural and political actor (Jasanoff and Wynne, 1998; Jasanoff, 2003). However, methodological difficulties and disciplinary biases are also to blame. Research into the role of culture and politics in science are limited by practical difficulties of studying elites; access is generally a problem for those wanting to study scientists, especially elite scientists involved in political affairs evolving in part behind closed doors.

The scientists in the climate backlash are also not an obvious focus of research because they are so few. On the climate issue, the backlash has tended to rely on a group of ten or so scientists of varied backgrounds and social and scientific status[8]. They thus do not constitute a highly attractive focus of research in fields such as anthropology and sociology, which tend to favor studies of larger populations. Yet, in an individualizing society (Beck, 1992; Ester et al., 1994), social affairs are increasingly marked by the actions of small heterogeneous groups and individuals, as in the case of the scientists who have lent important scientific authority to the environmental backlash on the climate issue. Understanding of key social dynamics can thus require attention also to the role of individuals. This is awkward for anthropologists and other social scientists due to the tradition of confidential informants. However, maintaining the trio's anonymity appears nearly impossible given the small sample and the trio's high-profile, the weight of particularities of their backgrounds and the institutions with which they affiliate. Moreover, as the social usefulness of the analysis depends on knowing the particularities of their personalities, affiliations and backgrounds, the analysis would make little sense if their identities were not disclosed, even if it were possible. They are high-profile elite scientists and public figures, not interchangeable rank and file scientists, and while they are constituted at the crossroads of cultural currents, who they are as individuals matters for the story. Moreover, the merits of maintaining their anonymity must be considered in light of the non-democratic nature and profound impacts of the anti-environmental movement that they have helped strengthen (Lahsen, 2005b).

[7]In addition to the physicists discussed here—Frederick Seitz, William Nierenberg and Robert Jastrow—high-profile and persistent scientific dissidents on the climate issue include S. Fred Singer, Sallie Baliunas, Willie Soon, Hugh Ellsaesser, Patrick J. Michaels, Sherwood Idso, Robert Balling and Arthur Robinson. These scientists are variously meteorologists and climatologists, geographers, chemists and physicists. They live scattered around the United States, variously affiliated with universities, national laboratories and private organizations such as the Marshall Institute and the Cato Institute.

[8]While they may have sympathizers within the scientific mainstream and associated institutions, identifying such sympathizers is a research task in itself and hence a deterrent to analysis. Occasionally, skeptical scientists within the mainstream have been enrolled in the oppositional campaigns of the cadre of high-profile critics of concern and policy action on behalf of human-induced climate change. For example, two petition campaigns (in 1992 and 1996 respectively) orchestrated by atmospheric physicist S. Fred Singer's organization, the Science and Environmental Policy Project (SEPP), featured a fair number of meteorologists—weather forecasters and weather researchers. The petitions protested IPCC claims of a scientific consensus on the climate issue and expressed skepticism of the evidence of human-induced climate change and urged government not to undertake hasty action on the issue. Overall, however, the dissenting side has encountered difficulties in terms of attracting new Ph.D.s to their ranks. I base this statement on ten years of research involving monitoring of media articles and events on the climate issue as well as more than a hundred interviews among US scientists involved with the climate issue or knowledgeable about US climate science and politics. This research suggests that only few new actors have joined the ranks of the staunch scientific skeptics on the climate issue since it gained widespread attention in the late 1980s. This is also reflected in efforts on the part of industrial and political groups to seek out and train new persons to join to the ranks of outspoken critics of policy action on behalf of human-induced climate change. See Cushman (1998).

Considering all of the above, journalistic standards appear most appropriate: according to them, it is proper to reveal the identities of persons when they are public figures.

Data presented here was collected as part of research among atmospheric scientists using the anthropological methods of participant-observation and interviewing over a period of years beginning in 1994. Of the physicist trio, two were interviewed in person, and showed themselves to be remarkably frank. It was not possible to interview Robert Jastrow, wherefore I resorted to numerous persons who knew him. In all three cases, interview data was supplemented by study of materials by or about them as individuals and the groups with which they affiliate.

The majority of work discussing the dissenting scientists involved in US climate politics has been by scientists and journalists without grounding in social science literature (see among many others, Begley, 2007; Gelbspan, 1995, 1997; Helvarg, 1994; Hertsgaard, 2006; Houghton, 1997; Kellogg, 1987, 1991; Mother Jones, 2005; Rowell, 1996). This popular literature tends to highlight financial benefits enjoyed by backlash scientists through affiliations with industry and conservative groups.

The anti-environmental movement is indeed in large part built by industry and conservative groups' who mobilized considerable resources to weaken environmental critiques threatening capital accumulation and the impetus for continued economic growth (Allen, 1992; Begley, 2007; Diamond, 1995; Ricci, 1993; Salisbury, 1997; Stefancic and Delgado, 1996). However, this paper belies the simplicity of explanations of the trio's involvement with this movement in terms of calculations of financial gain.

2. The trio and the George C. Marshall Institute

The trio has launched many of their activities related to climate change through the George C. Marshall Institute, a conservative Washington, DC-based think tank they co-founded in 1984 to influence public opinion and policy. The Marshall Institute is part of the anti-environmental backlash and the broader conservative network financed by political elites in reaction to the move to the left pushed by protest politics in the 1960s and '70s (Diamond, 1995, 1996; Fischer, 1991; Ricci, 1993; Rowell, 1996; Saloma, 1984; Soley, 1991). In the words of Frederick Seitz (1994, p. 384), former Chairman of the Marshall Institute, the institute "encourages research on defensive anti-ballistic missiles, on space science, and critical studies of factors that could have a major effect on the environment." While the Marshall Institute's internet website (www.marshall.org) claims that the institute produces reports that are objective and unbiased,[9] Marshall Institute analyses consistently promote unregulated free-market forces, military defense technology, and nuclear power, while opposing environmental regulation. During the Reagan Administration, the Marshall Institute promoted the Strategic Defense Initiative (SDI), a space-based defense system intended to protect the United States from nuclear attack by means of satellites, lasers, and ground-based missiles (Park, 1987). When new environmental problems gained prominence, the institute—and the broader conservative movement of which it is part—paid attention to those as well.

The trio is part of a physicist elite that dominated the science-policy interface for decades. Decision makers at the top levels of the US government have looked or referred to them as sources for their interpretations of the threat of climate change, privileging their (non-peer-reviewed) Marshall Institute assessment report of climate change over that of the hundreds of scientists comprising the IPCC (Fleagle, 1994; Rowlands, 1995, p. 80).

Like others, politicians often select scientific expertise on the basis of pre-established political agendas (Jasanoff and Wynne, 1998; Thompson and Rayner, 1998). References to specific experts is therefore not necessarily a sign that the latter have actually influenced the positions of persons who cite their scientific authority or have actual power to steer US policy related to climate change. However, the trio undeniably forms an influential—and also the most prestigious—faction among US contrarian scientists with respect to climate change. Their involvement has lent the backlash power and credibility due to the high status they have enjoyed for outstanding achievements in science and due to their ties to political decision-makers. Their influence has been evident in the widespread circulation and reception in the US Congress and elsewhere of reports they have produced and controversies they have helped instigate (Lahsen, 2005b; McCright and Dunlap, 2003). Moreover, Frederick Seitz has helped lead several high-profile efforts to discredit the theory of climate change and the credibility of the IPCC and IPCC scientists who advance the theory and promote policy action on its behalf (Edwards and Schneider, 2001; Lahsen, 1999, 2005b).

As of February 2003, the George C. Marshall Institute's website featured a staff of five, including one scientist, Willie Soon. Willie Soon, "Senior Scientist" with the Marshall Institute, is a physicist at the Solar and Stellar Physics Division of the Harvard-Smithsonian Center for Astrophysics and an astronomer at the Mount Wilson Observatory. He collaborates extensively with Sallie Baliunas, another physicist climate contrarian affiliated

[9]The Marshall Institute's homepage on the internet reads: "In every area of public policy, from national defense, to the environment, to the economy, decisions are shaped by developments in and arguments about science and technology. The need for accurate and impartial technical assessments has never been greater. However, even purely scientific appraisals are often politicized and misused by interest groups. The Marshall Institute seeks to counter this trend by providing policymakers with rigorous, clearly written and unbiased technical analyses on a range of public policy issues. Through briefings to the press, publication programs, speaking tours and public forums, the Institute seeks to preserve the integrity of science and promote scientific literacy" (http://marshall.pjdoland.com/category.php/6.html, accessed 20 November 2007).

with the conservative movement (McCright and Dunlap, 2003) and the Marshall Institute. Baliunas serves as a member of the institute's Board of Directors. The website identifies the physicist trio—Frederick Seitz, Robert Jastrow, and William Nierenberg—as founders of the Marshall Institute. Nierenberg died in 2002 and is commemorated on the Marshall Institute website.[10] Jastrow is the present Chairman of the institute, a position until recently occupied by Frederick Seitz.

The Marshall Institute Board of Directors included a total of thirteen persons—six scientists (five physicists and one biochemist), two engineers (one of whom is also an economist), a medical doctor, an "author," a syndicated columnist, and two business men with strong ties variously to the oil industry and the military industrial complex (one is former Executive Vice President of the American Petroleum Institute, the other Senior Advisor to Lockheed Corporation). Another member of the Board of Directors is the physicist William Happer. Happer is also a chairman of JASON, a group of which Seitz and Nierenberg also are/were members. JASON totals about fifty "exclusive" scientists and engineers who have advised the Federal Government on matters of defense and other technical issues since the 1960s (Finkbeiner, 2002). This group, which formed in the context of Sputnik, provides technical advice on defense policy-relevant issues. It has operated largely in secret and has long-standing, strong connections with people in power, including present Congressional representatives and the W. Bush Administration (Nature, 2002).[11]

The Marshall Institute trio has influenced top-level political decision makers' positions on the climate issue. Their 1989 Marshall Institute report (Jastrow et al., 1989)—which, like other reports issued by the institute refuted concerns about human-induced climate change, was not peer-reviewed—have found receptive audiences, especially among conservatives and some representatives of fossil-fuel interests. According to the Marshall Institute itself, the trio's 1989 report "dominate[d] White House thinking" on climate change during George H.W. Bush's presidency (1988–1992). It is also said to have "provided the foundation for the [Bush] Administration's resistance to scientifically unjustified limits on carbon dioxide emissions" (Atmosphere Alliance, 1995, p. 17). When asked to comment on the IPCC's first (1990) assessment report, President H.W. Bush preferred to defer to the 1989 report by the George C. Marshall Institute, saying: "My scientists are telling me something very different" (Rowlands, 1995, p. 80). Bush's reference to "his scientists" reflects the "demonopolization" of science (Beck, 1992), that is, the fact that in the face of new environmental problems, science plays an important yet insufficient role in establishing socially binding definitions of truth in this context, attitudes towards the issues and technologies involved guide interpretations of the science. Bush's reference also reflects the fact that peer-review is not necessarily a decisive factor in top-level political decision-makers' selection of scientific evidence (for other evidence of this, see Lahsen, 2005b). While the anti-environmental movement has been weakened in step with the consolidation of scientific and popular concern about the issue, it is still strong. As a story in *Newsweek* showed and concluded as late as this August (2007), those who have long challenged the mainstream scientific findings about global warming are not giving up. The same story identified the Marshall Institute as "a central cog" in the anti-environmental network that continues to shape both government policy and public opinion (Begley, 2007).

Of the three physicists, Frederick Seitz has been particularly active in the backlash (Lahsen, 1999, 2005b), a central figure in a series of climate-related episodes. The first episode erupted around revisions to the eighth chapter of the 1995 IPCC Assessment Report. In an op-ed in *The Wall Street Journal*, Seitz charged that IPCC leaders made unauthorized changes to the chapter to "remove all hints of skepticism" from the scientific discussion as to whether or not the evidence indicates a human influence on the global climate (Seitz, 1996).[12] Seitz also played a central role in the controversial 1998 Anti-Kyoto Protocol Petition, which collected more than 15,000 signatures.[13] Seitz wrote the cover letter to that petition document which urged the US government to reject the Kyoto Protocol. The petition rejected the treaty on the grounds that there is "no convincing evidence that human release of carbon dioxide, methane, or other greenhouse gases is causing or will, in the foreseeable future, cause catastrophic heating of the Earth's atmosphere and disruption of the Earth's climate" while there is "substantial scientific evidence that increases in atmospheric carbon dioxide produce many beneficial effects upon the natural plant and animal environments of the Earth." Jastrow and Nierenberg were among the signatories.

The primary concern of this article is not to arbitrate over these and other controversies, each of which requires careful analysis of the actors, discourses, actions and issues involved. Rather, the aim is to discuss likely reasons why

[10]Although Nierenberg is dead, I will describe the trio the present tense for stylistic reasons.

[11]In November 2007, the Board of Directors has shrunk to 9 persons, but it still includes 5 physicists (Seitz, Jastrow and Happer, along with Gregory Canavan and Robert L. Sproull), an economist/engineer, a former CEO and President of the New York Academy of Sciences, CEO of a consulting company (and also Chairman Emeritus of the anti-environmental Global Climate Coalition) and the author, whose specialty is defense topics such as military technology, terrorism and the Cold War.

[12]Analyses of the revisions to the chapter 8 of the 1995 IPCC report do not support Seitz's claims that "all hints of skepticism" were removed nor that the peer-review process was corrupted. Such analysis does, however, highlight the important role of interpretation and negotiation of meaning inherent in the production of such assessment reports. For analysis of the controversy, see Edwards and Schneider (2001) and Lahsen (1998b).

[13]For a complete transcript of the petition and a list of signatories, see http://www.oism.org/pproject. For discussion of the petition campaign, see Lahsen (2005a).

these elite physicists have chosen to be part of the anti-environmental movement.

The paper first discusses the trio's style of engagement, suggesting that their professional training has disposed them to exhibit a self-confident, skeptical and confrontational style of interaction, a style that has propelled their resistance to the widespread concerns about human-induced climate change and other environmental threats. However, the trio's relative lack of receptivity to both scientific and political arguments supporting concern about global climate change may also be understood in terms of other, broader social dimensions. Importantly, as I describe below, the trio's status, the institutions with which they identify and affiliate, and their normative frameworks as a whole, are challenged in numerous ways by developments since the end of the 1960s, including the rise of the peace and environmental movements, the end of the Cold War, and changes in federal funding of science that have negatively impacted theoretical physics. The trio's engagement with the environmental backlash might be interpreted as resistance to these recent historical forces and associated trends which extend critical analysis to techno-science itself. The trio rejects understandings of "production science" creations—nuclear technology, DDT, CFCs etc.—as dangerous to society, emphasizing instead the social benefits of these creations and upholding faith in humans' ability to avoid and control their negative side-effects.

3. Ties to an earlier era and national defense

The trio's engagement with the backlash can, in part, be read as a reaction to a loss in privilege and a general decline of physics. Nierenberg, Seitz and Jastrow were all born in the years between 1911 and 1925 and obtained their Ph.D.s in physics in the New York and New Jersey region in the years between 1934 and 1947. They know each other since the early stages of their careers (in the case of Jastrow and Nierenberg, since their days as graduate students at Columbia University) and have in various capacities been affiliated with the same, or overlapping, scientific and defense-related bodies. These scientists cannot be dismissed as lesser or "pseudo-scientists," despite efforts on the part of their critics to do so (Babbitt, 1997); they are extraordinarily accomplished scientists who throughout their careers have served on a large number of governmental panels and influential scientific advisory committees, filling positions even as chairs of reports issued by the National Academy of Sciences. During the Second World War and the postwar decades, the trio's talent and scientific training brought them into close relationship with political leaders in charge of national defense.

Robert Jastrow, former president of the Marshall Institute and now chairman of its board of directors, received his Ph.D. in physics in 1948 from Columbia University, after which he accepted a position with Princeton's Institute of Advanced Study, among other places. He was educated as a theoretical physicist and specialized in astronomy and astrophysics theory. During the late 1950s and early 1960s, he served as head of the theoretical division at NASA's Goddard Institute for Space Science (GISS) before becoming director of the New York-based center in 1961, where he remained for 20 years. Between his posts at Princeton and GISS, Jastrow worked with nuclear physics in the US Naval Research Lab in Washington (1958–1961). Late in his career, he served as professor in earth sciences at Dartmouth College and director of the California-based Mount Wilson Institute. Like Nierenberg and Seitz, Jastrow is a member of the National Academy of Sciences.

Frederick Seitz, chairman of the Marshall Institute, received his Ph.D. in physics from Princeton University in 1934. Seitz was trained under the prominent nuclear physicist Eugene Wigner, among others. In 1940, Seitz published a seminal book on solid-state physics and materials physics. He has also contributed significantly to the understanding of defect properties of solids and radiation damage, among other things. Seitz joined the Physics Department at the University of Illinois in 1949, where he later served as department head, dean of the Graduate College, and vice-chancellor for research. In 1965, he became the first full time President of the National Academy of Sciences, after which he served as President of the American Physical Society and Rockefeller University. Seitz served as variously Chairman, Vice Chairman, and Science Advisor to the Defense Science Board, and to NATO (Reed Reference Publishing Company, 1994) and was also associated with the President's Scientific Advisory Committee (PSAC) throughout its existence. In the late 1980s, when the Reagan Administration was pushing the SDI, Seitz simultaneously chaired and advised so many institutions promoting the initiative that an executive director with the American Physical Society referred to him as "the ubiquitous Seitz" (Park, 1987). Prior to SDI, Seitz helped direct R.J. Reynolds Industries, Inc.'s multi-million-dollar program for health research, an initiative it used to create scientific legitimacy for skepticism regarding evidence of adverse health effects of smoking (Hertsgaard, 2006).

William Nierenberg was a prominent physicist member of the Marshall Institute until his death in 2000. He received his Ph.D. in physics from Columbia University in 1947 (a year ahead of Jastrow) and worked as a research scientist at the Manhattan Project while in graduate school (1942–1945). His early research focused on magnetic moments. In the 1950s and 1960s, he served as member or consultant of the Mine Advisory Committee at the National Research Council, the Committee on Nuclear Constants, and the National Security Agency of the President's Special Project Committee. Nierenberg was also advisor at large to the Department of State during this time and a member of the prestigious National Science Board, among many other panels and committees (Reed Reference Publishing Company, 1994). Nierenberg

succeeded Seitz as Science Advisor to NATO in the 1960. After a series of professorships at different universities inside and outside the United States, he served as director of Scripps Institute of Oceanography and vice-chancellor of marine sciences at the University of California, San Diego.

The Marshall Institute physicists enjoyed great privilege during the first several decades of their professional careers in terms of the status, influence, and funding they enjoyed. An important aspect of the US postwar social contract with science was the presence of scientists as advisors in the inner circles of political decision-making (Brickman, 1979; Golden, 1991; Smith, 1994). In 1957, the science advisory apparatus was formalized with the official appointment of a Presidential science advisor and an advisory committee on science (PSAC) in the White House, important symbols of the social status of science and scientists. The trio was part of a small group of nuclear scientists which dominated the science–government interface in the US for most of the twentieth century (Schwartz, 1996, p. 154).

Physicists' centrality in maintaining American military dominance and hence national security during the Second World War and the Cold War brought them power and high prestige in US science, government and society (Kevles, 1995 (1971); Zuckerman, 1977). Some physicists pushed to end or slow the arms race, but whichever side they took on issues of arms control and defense, "physicists remained honored and empowered because they remained essential in determining the shape and capabilities of American national security" (Kevles, 1995 (1971), p. ix).

The status and privilege of the defense-connected physicists began to change in the 1970s, at a time when the Marshall Institute trio was at the height of their influence. The environmental and peace movements spread perceptions of nuclear technology as a "symbol of all that was wrong with society" (Hajer, 1995, p. 91). The nuclear issue became a central target for environmental fears about human survival and health, as did climate change years later. With the fears about human survival due to new environmental risks rose the notion that science and technology could have deleterious effects. No longer presumed to be a social good, institutions and processes were subsequently built to evaluate science and technology. Earth Day 1970 symbolized and further strengthened the rise in environmental concern, and establishment of the Congressional Office of Technology Assessment (OTA) in 1973 reflected the new view of science as needing to be controlled and assessed. Congress gained new power and grew more involved in all aspects of policy-making, diminishing the power of the executive branch and the existing scientific advisory network.

As a whole, these developments compromised the privileged and uncontested voice in policy-making that the defense-affiliated physicists had previously enjoyed. The demonopolization of science rendered it more open and contentious as the split grew between scientists working on the side of military defense and scientists involved in non-defense-related science (Smith, 1994). In the 1980s, "impact sciences" (i.e., lines of scientific inquiry focused on the detrimental environmental effects of human actions) grew significantly and began to divert scientific funds from "production sciences" oriented towards the production of things through traditional applications of engineering, economics, physics and chemistry (Schnaiberg, 1980).

Seitz and other Marshall Institute colleagues personally experienced negative consequences of the above changes, including, perhaps most importantly, a reduction of their scientific power and privilege. In his memoir, Seitz expresses the depression he experienced as a result of the new political environment that began to develop in the 1960s (Seitz, 1994, p. 329). Seitz was associated with PSAC when President Nixon dissolved it in 1973 and ousted all science advisors from the White House due to the tension between the Administration and "peace scientists" within the advisory committee. Disputes over supersonic transport and the Antiballistic Missile Treaty reflected "deep-seated political differences" among certain PSAC members and consultants-at-large and the Nixon administration (Smith, 1994, p. 48).[14] Seitz is strongly critical of the anti-militarism of the Committee members who provoked the loss of scientific power in the Executive branch of government under Nixon (Seitz, 1994, p. 297). The behavior of these PSAC members, writes Seitz, "did their best to demean any military officer and, on occasion, even civilian members of the Department of Defense" (Seitz, 1994, p. 299). As a defense-related scientist who at the time served as president of the National Academy of Sciences, Seitz found himself at the opposite side from the emerging anti-war movement in the 1960s and early 1970s.

In his memoir, Seitz also mentions the establishment of the Office of Technology Assessment (OTA) in the mid-1960s. He says that due to "the changing spirits of the times," the OTA "soon turned into a rallying hall for the nay-sayers who were available in abundance"—nay-sayers who brought about an "imbalance" in the OTA with their emphasis on the "negative side effects" of science and technology (Seitz, 1994, p. 385n9).[15] Seitz's also expresses a modernist faith in Progress and in cultural evolution, rejecting the cultural relativism characteristic of many Americans who came of age during the 1960s and 1970s (p. 377).

4. Faith in techno-science

As reflected in Seitz' description of the OTA, the Marshall Institute physicists manifest a level of faith in

[14]Science advisory functions were not entirely abolished insofar as a research staff established by National Science Foundation took over some of the advisory functions of the old White House science office. But Nixon felt no need for a formal scientific presence in the White House (Smith, 1994).

[15]The OTA was abolished in 1995 by the Republican-dominated Congress at the height of the "Republican Revolution."

science and technology not shared by their opponents on the issues of nuclear technology and climate change. The Marshall Institute scientists are generally not receptive to the survival discourse—at least as applied to climate change and other new environmental problems (see below). Their discourses generally reveal a pre-reflexive modernist ethos characterized by strong trust in science and technology as providers of solutions to problems, whether environmental, social, or economic, an understanding of science and progress that prevailed during the first half of the 20th century.

Nierenberg and Seitz implicitly reject the notion of nature as fragile. They also do not accept pronouncements of impending environmental apocalypse. They are "high-proof" scientists (Hays, 1987) when it comes to evidence of environmental *threats* (whereas proponents of concern about climate change require high levels of proof when it comes to environmental *safety,* i.e., subscribe to the precautionary principle). In his interview with me, Nierenberg refuted widely accepted evidence related to stratospheric ozone depletion and its widely feared repercussions for human health ("Do you know that there is no real evidence of melanoma being caused by ultra-violet B? Are you aware of that? In fact, it probably isn't"). Nierenberg also expressed support of continued use of DDT to combat malaria.[16] His positions reflected rejection of the fragile nature paradigm, faith in the benevolence of technology widely shunned on environmental grounds, and belief that such technology can reduce humans' vulnerability to the environment.

Seitz and Nierenberg do not rule out the possibility that humans might be changing the global climate. Moreover, in his interview with me, Seitz identified overpopulation as a cause of concern, thus appearing to have accepted the notion that earth has a finite level of natural resources, a notion identified with the environmental paradigm (Catton and Dunlap, 1980). However, they believe that we can afford to wait numerous decades to better diagnose the climate problem and develop solutions; in his interview with me, for instance, Nierenberg stated that "nothing serious" or "no big effects" in terms of climate change will happen for 150 years.

Seitz and Nierenberg are in overall agreement with proponents of concern about climate change that the solutions depend on substitution of fossil fuels with new technologies. The difference between the two groups is that the trio's opponents believe in raising environmental concern and instigating governmental intervention to trigger and nurture the innovation. By contrast, the trio appears to believe that the technological innovation will happen without such intervention, a stance that harmonizes with the conservative movement's general anti-regulatory agenda.[17] Another difference is technological preferences. Nierenberg and Seitz support nuclear technology as a solution to numerous problems, including climate change. As Nierenberg said in his interview with me:

> I'm sure we can lay out today the problems of nuclear energy disposal, the weakness in the structure of the reactors, and a couple of other problems… in 40 years, 20 years, we can solve them cold, and by 40 years we can have nuclear energy all over the place again.

Seitz has advanced the same view through the pro-nuclear Scientists and Engineers for Secure Energy (SE^2), a think tank he and a physicist colleague established with support from the nuclear energy lobby (Deal, 1993, p. 91). Pointing to the "early postwar successes" of nuclear technology (Seitz, 1994, p. 384), Seitz advocates continued development of nuclear technology. By contrast, scientific proponents of concern about climate change tend to be wary of nuclear technology, singling out its environmental dangers over its potential social and environmental benefits.

5. Professional socialization: learned self-assertion and discounting of techno-scientific risks

The Marshall Institute physicists' "high-proof" attitude with regards to environmental risks and their strong faith in science and technology have roots in an earlier historical era and in their professional socialization; their dispositions harmonize with dominant attitudes during earlier stages of modernity and bear the imprint of particular social circles. In particular, the trio's experience with atomic weapons research and weapons researchers is likely to have influenced their view that the negative side-effects of nuclear technology can be avoided through rational planning and control. While they are not nuclear physicists themselves, strictly speaking, the trio is enmeshed in the culture of nuclear physics. As noted above, all three knew and were trained by prominent nuclear physicists and were part of their circles, e.g., through participation in the Manhattan Project. As Section Leader during the Manhattan Project, Nierenberg worked on uranium isotope separation using atomic beams. While the latter is not nuclear physics strictly speaking, some may consider it such. Jastrow was similarly a mainstream physicist who developed expertise in astrophysics. His work in astrophysics was closely linked to nuclear physics, among other things through his focus on phenomena associated with the Big Bang. He also served as consultant on nuclear physics at the Naval Research Laboratory.

In the process of being trained (in part) by nuclear physicists about nuclear-related physics, one can surmise from anthropological research that the trio also was

[16] Nierenberg said: "the proper application of DDT in many … countries would cut a major fraction of [annual deaths from malaria]. Why are they arguing against it? Well, the insects are showing resistance to DDT. You say, okay, show me the evidence. I can't find it. And even if some did in some areas, they don't in others".

[17] See exchanges between Nierenberg and Robert Watson (US Government, 1996, pp. 257–261) that reveal these differences.

encouraged to think and act in particular ways. Their cultural ways of thinking and acting also underpin their engagement in climate politics, as they are prone to create tension. Anthropological studies of physicists suggest that physicists' professional socialization nurtures particular modes of interaction and understanding, including a self-confidant style of self-presentation and an inclination to discount techno-scientific risks and to approach even highly complex scientific problems with confidence. Based on ethnographic research among nuclear scientists, Gusterson (1996) argues that nuclear weapons scientists are taught to value science and technology and to trust humans' ability to control it in socially beneficial ways. Weapons research and research laboratories inculcate a culture of expert rationalism that encourages the suppression of emotionalism in favor of logic and problem solving; they learn to not attend to particular fears, feelings and questions and to "revile" anti-nuclear environmental activists' emotionalism (Gusterson, 1996, p. 204). Such scientists also grow into a sense of privilege, writes Gusterson, including a tendency to believe that they alone are entitled to an opinion on nuclear policy. The trio's association with weapons research and weapons researchers thus induces a sense of privilege, which also is nurtured by their achievements in science and their high-level roles as policy advisors.

In her ethnography of high-energy physicists, Traweek (1988) writes that success within the field of physics is won by means of self-assertion and bravado, which may include disdaining the work of others. This is often meant and seen within this subculture as an expression of willingness to "expose mediocre work, no matter who has done it;"

> The desired presentation of self can be characterized as competitive, haughty, and superficially nonconformist […] One group leader said that to convince others of the validity of one's work one had to have great confidence and be very "aggressive"; he added that one needed a certain "son-of-a-bitchiness" (pp. 87–88).

The style is not necessarily unfriendly but can be construed as such, especially by persons unfamiliar with it and unaware of its cultural dimensions. It is confrontational, however, and generally dismissive if not disdainful of competing views.

Numerous climate scientists interviewed as part of the author's larger research project associated the Marshall Institute trio with this general style of behavior. Thus, a chemist and climate scientist said:

> Jastrow, Seitz, Nierenberg—the Marshall Institute in general, I know all of these guys. They are all good scientists—they *were*: they are all retired, and they have a kind of hubris—an arrogance, you know […] Physicists can answer any question quickly. These [global environmental] problems are sort of trivia that can be handled by a good physicist on a Friday afternoon [over] a beer. That is the attitude they have. […] They downplay the science of any other community. And they are really arrogant.

An IPCC leader—a physicist himself—echoed the above statement:

> [There is a group of physicists among the contrarians who] feel that they are experts [on the climate issue]. There is a long-standing tradition in the physics community that holds that physicists can solve any problem just by thinking about it. There is a group in the US called JASON … These physicists meet down in Southern California, and they were convinced that they could solve any problem. […] They were convinced they could solve the acid rain problem intellectually. They didn't care about models and clouds and other detail. They thought they could do it from first principles of physics. And there is some of that left over.

Overhearing the above comments, another IPCC leader and scientist pitched in: "You see, there are scientists who have been working at the highest levels in science and government, who feel as if they can make statements about any scientific area. But what they have to do first is their homework!" While the JASONS raison d'être was to solve any problem in any field on the basis of mathematics and physics, their expertise and competence is questioned in the environmental field.

The physicist style was a theme in numerous interviews, and was noted as particularly strong in the case of the trio. The following younger generation physicist and atmospheric scientist discussed the trio in terms of physicists' inclination to believe themselves to be experts on "everything" due to their physics training. He was unfamiliar with the trio's arguments on the climate issue but said he had encountered the above-mentioned tendency in a report they wrote on the Strategic Defense Initiative during the Reagan Administration in the 1980s. He and two colleagues publicly criticized the report for alleged technical flaws. They had no prior knowledge of the trio but recognized that the latter had very impressive scientific credentials. In his interview with me, the young physicist interpreted the Marshall Institute SDI report as an instance of physicists' inclination to think themselves experts on everything:

> Young physicist: [Physicists learn] a way of thinking, a way of looking at problems… See—this is a problem with physicists: they think they know everything, because they're smart. What they don't understand is that yes, it is true, actually meteorology is a branch of physics. And so you take a physicist, like me, and you can sit him down, and in 2 or 3 years, they could learn meteorology. But physicists confuse being smart and having the *ability* to learn everything with actually *knowing* stuff! There is a difference between having the ability to learn and actually having learned, and there is also a difference between understanding certain physical principles, which physicists do, and then knowing

certain facts. Physicists always think 'oh, I'm a physicist, I understand astronomy.' But really, you don't, because, for example, in astronomy there are just things you have to know. For example, you have to know how big the galaxy is. And being a physicist doesn't automatically teach you how big the galaxy is. You might understand the physical laws that govern the galaxy, but you don't know these facts: you don't know how big it is, you don't know what it's made of, you don't know what the planets are made of—there are just a lot of things you don't know. So physicists think they know everything, I mean, they get confused between having the ability to understand everything—which they more or less have—and then actually *knowing* everything.

Interviewer: Why don't chemists do the same thing?

Young physicist: Why don't they have a similar arrogant attitude [*small laugh*]? I don't know!

Whether or not physicists count as experts on any given issue involving physics is to some extent a matter of judgment, as are judgments as to whether or not they have "done sufficient homework." Such distinctions must be understood as "boundary-work" (Gieryn, 1983), that is, as discursive, socially inflected strategies to define reality in particular ways. Moreover, the issue of expertise has complex dimensions when it comes to uncertain, future-set global environmental problems. Even experts face great uncertainties when it comes to defining high-stakes global environmental problems such as human-induced climate change as well as its impacts and possible solutions; no one expert grasps the total, and lay persons can contribute important knowledge and values to associated deliberations (Funtowicz and Ravetz, 1992, no year). Nevertheless, these Marshall Institute physicists were not trained as environmental scientists, did not publish in the field and were not part of the climate community, and they can therefore also not be said to be climate experts.

Scientists working in the area of climate change do not appreciate the Marshall Institute scientists' confident assertions about climate reality, especially when such assertions categorically dismiss the importance of large research efforts in climate science. In his interview with me as in many public fora, Nierenberg presented this view with a level of confidence, sweepingly dismissing the importance of the General Circulation Models (GCMs), the central technology in climate research by means of which projections of future climate are produced and explored. He instead favored his simple "back of the envelope" calculation according to which temperature increases over the next century will be about half a degree Celsius, arguing that the climate models are slowly approaching his long-standing estimates. He did not find it necessary to rely on "those giant computers which have all those facts in them," adding "As far as I am concerned, the situation [i.e. predicting future climate changes] is fairly simple. The science has been simple."

Aside from defenses on the part of environmental scientists in favor of climate modeling, the trio's rhetorical style is likely to be misunderstood or considered intolerable by some scientists and politicians and to further antagonize the debate between these physicists and those whose views they challenge. This style renders the trio valuable to promoters of the backlash; while speculative hypothesis generation is an important, creative process among scientists, it can also become political fodder in the scientized politics of the environment.

6. Defenders of basic science—and of their status

The Marshall Institute trio's engagement on the side of the backlash is part of their battle to preserve a normative framework related to science as well as science funding patterns characteristic of the postwar decades—decades during which production science enjoyed greater dominance and prestige. Postwar US science policy was based on the assumption that government support of all science, including basic science of little immediate or obvious relevance to society, always eventually results in social benefits exceeding the investment. This policy assumption, and the prestige of scientists due to their role in winning World War II, secured unprecedented high levels of federal funding for science without demands on scientists to integrate their research with broader policy issues (Guston and Keniston, 1994; Kevles, 1990; Pielke, 1997).

Seitz and Nierenberg present themselves as strong advocates of a continuation of the funding policies of the postwar decades and criticize a new direction in national science policy towards greater emphasis on applied research, a practice that has benefited "impact" sciences in the environmental field, including climate science. They claim that the present emphasis on applications results in "much mediocre science" (Seitz, 1994, p. 390). In line with this, Seitz's memoir honors Vannevar Bush whose postwar science policy emphasized basic science, deeply shaping US science policy up until the present. Seitz suggests that Bush's "wise council concerning the support of basic research" needs to be "reiterated in each generation," arguing that "[t]he best way to support research is to provide funds to the most gifted scientists and then allow them the freedom to determine their own research agendas" (ibid., p. 388).

Along the same lines, Nierenberg expressed in his interview with me that the GCMs projecting future climate change do not merit their present level of funding: "You could say, why are they spending a billion and a half dollars a year**?** Why has that not been narrowed?" When I asked Nierenberg what he would like to see funded in place of the GCMs, he responded without hesitation: "basic science." He also suggested political motives for the strong funding climate modeling enjoys. Like Seitz, Nierenberg complained that politics rather than scientific merit now dominate federal funding policy, by contrast to earlier times.

Despite popular myths to the contrary, studies have shown science to have been similarly steered by broader national political priorities in the postwar decades, only then the priorities were structured by US foreign policy objectives related to the Cold War (Forman, 1987; Kevles, 1990). Similarly, Vannevar Bush's emphasis on basic research and the associated rise of federal funding of science were grounded in perceptions of it as key to national security and commercial strength, and these goals shaped scientists' pursuits.[18]

At a deeper level, then, it is less that the trio is against having practical and political priorities shape science agendas than that they do not agree with the new priorities shaping present science funding, including the demotion physics has suffered in the post-Cold War era. Seitz, Nierenberg and Jastrow supported those Cold war plans, and did not mind when federal funds were going to science associated with Cold War national security plans. Indeed, they promoted and helped enhance that linkage. The trouble came when the agenda changed.

Federal funding for basic science and physics research has steadily declined, while new fields (including environmental science and, especially, biomedical science) have enjoyed increased funds due to new social concerns. For instance, inflation adjusted funding for nuclear power research and development decreased by sixty percent from 1980 to 1990 (Sarewitz, 1996, p. 154). In 1991, an informal survey found physicists' morale "universally low due to the changing times, their field now suffering from inadequate funding for increasingly expensive and larger scale non-environmental research" (Kleinman, 1995, p. 189). The frustration of physicists grew when the Clinton Administration came into power and the Democrat-dominated Congress ended the costly Superconducting Supercollider (SSC) project. The latter was a severe blow to the field of high-energy physics and it marked the beginning of a new, less privileged relationship between physicists and the federal government (Kevles, 1995 (1971), p. xii). In his memoir, Seitz describes the SSC machine as "magnificently conceived," associating its defeat with the US Congress' "lack of fundamental understanding of the scientific base upon which our current civilization rests" and a sign that the US may be in for "deep trouble" due to decreasing appreciation of the importance of science and technology (Seitz, 1994, p. 390).

By contrast to common suggestions, these scientists' motivation is not fundamentally rooted in desires for financial gain. Being past retirement age and no longer active scientists, their fight for basic science, for instance, does not benefit them individually. And it is hard to believe that, upon retirement, these physicists would jeopardize their cherished professional images for mere financial gain as consultants. A more convincing reason for their engagement with the backlash is that they are defending what they consider good and right—a normative framework that endows them with the prestige, respect, and funding to which they feel entitled and which entails particular understandings of the relationship between nature, society, science and technology.

The trio feels entitled to prestige. The assumption that they consider nuclear physicists the top of the top is reflected in Nierenberg's off-the-cuff comment about agricultural scientists at a Congressional hearing: "They are not nuclear physicists, so we don't think much of them" (US Government, 1996, p. 257). Dismay at the decline in respect they are given adds force to the trio members' already assertive rhetorical style. The following statement by Nierenberg expresses the outrage they feel at the lack of respect with which they now sometimes are confronted:

> You can take [Frederick Seitz, an] extraordinarily distinguished, almost—maybe the most distinguished living scientist we have. You see the names they call him because of his position. Absolutely extraordinary man! … He is probably most centrally responsible for the great strength of our country in solid-state physics. […] The things they call him are unbelievable. Usually by people who don't know him! And who don't know his background, which is even funnier. You know, a member of the National Academy of Sciences, and also of the Academy of Engineering, American Philosophical Society, the American Academy of Arts and Sciences—all earned for a lot of different reasons too.

In their dismay and their sense of violated entitlement, the trio has found support for important dimensions of their worldviews and policy preferences within the backlash and among Congressional Republicans. They must continuously contend with challenges to the privilege to which they had grown accustomed in science and government, however. In March 2002, the US Defense Advanced Research Projects Agency (DARPA) dropped its support of JASON. *Nature* described JASON scientists as "privately fuming" about the decision, which DARPA explained as based on an evaluation of the group as "focusing too heavily on physics" (Finkbeiner, 2002). An indication of the changing tides, DARPA found the JASONs' weighting towards physics "unfashionable" and "not keeping up with the times." The physicists' battle to preserve their scientific status—a battle I am suggesting also is reflected in the trio's engagement with the backlash—was suggested in the article's reference to their "refusal to accept what they regarded as a downgrading of their status" through the inclusion of government appointed scientists from what they consider inferior fields of science, persons with expertise in information technology and biowarfare.

The JASONs regrouped one month later, saved this time by political and financial support from a higher-ranked

[18]The idea of funding the most gifted scientists and granting them total freedom in their scientific pursuits is more correctly identified with the 1930s and with Andrew Carnegie in particular (source: Naomi Oreskes, personal communication).

Pentagon director who noted their value in post-9/11 times of terrorism and impending war in the Middle East.[19]

7. Other physicists of similar profile

Not all physicists are contrarians on the climate issue. It is important to attend to the role of individual choice and to the multiplicity of factors underpinning the Marshall Institute trio's engagement with the backlash. Age and scientific training are among the most central factors—if one considers also the experiences both factors have brought them, including the prestige they have enjoyed as experts on scientific issues related to national defense. Age means that the Marshall Institute trio absorbed a modernist ethos and that they lived to experience a new social paradigm emerge with which they were at odds.

If age, training by nuclear physicists, and experiences as governmental advisors on defense-related science are central (albeit underdetermining) factors underpinning the trio's opposition to the above-mentioned societal trends, then one would expect at least some other physicists of similar age and scientific training to share similar positions on the issue. This appears to be the case. One need not look further than other physicists affiliated with the Marshall Institute Robert Sproull and William Happer (above-mentioned members of the institute's Board of Directors) share important commonalities with the trio. Sproul is a Professor Emeritus of Physics at the University of Rochester who has served as chairman of the Defense Science Board within the Department of Defense. Born in 1918 and with a Ph.D. obtained during WWII, Sproull is of the same generation as the Marshall Institute trio.

William Happer—member of the Marshall Institute board of directors—is Professor of Physics at Princeton University. Happer is younger than the Marshall Institute trio and received his Ph.D. from Cornell University only in 1964. Like the trio, however, he has a background in nuclear physics, worked on the hydrogen bomb, and is actively involved in advisory activities related to defense science and a member of JASON. During the George H.W. Bush administration, Happer served as Director of Energy Research at the Department of Energy, a political appointee by President H.W. Bush. This would typically signal that his political beliefs also harmonize with a conservative political agenda, an additional factor likely to have encouraged his choice to join the backlash.

Another prominent example outside of the Marshall Institute is S. Fred Singer. Singer's biography shares important similarities with the Marshall Institute trio, including the time he was born (1924) and the nature and timing of his graduate training in physics at Princeton (1940s). Singer identifies as an astrophysicist, a field which involves a large amount of nuclear physics, and his mentor was the renowned nuclear physicist and theoretician John Archibald Wheeler (Kevles, 1995 (1971), p. 328; Singer, 1997, p. 175). Like Seitz and Nierenberg, Singer considers nuclear technology the promise of the future.[20] Like the trio, Singer also supports SDI technology, which he claims won the Cold War (Singer, 2002). Like the trio, his skepticism with respect to the climate issue is accompanied by similar skepticism with regards to a list of other issues with environmental dimensions, including the environmental effects of supersonic transport and stratospheric ozone depletion.

Like the trio, Singer has also joined the conservative movement. In 1990 he established the Science and Environmental Policy Project (SEPP), an institute included in the *Greenpeace Guide* to "anti-environmental organizations." SEPP receives money from industry groups and from private individuals and foundations with a primarily anti-regulatory framework to which he also subscribes (Lahsen, 1999; Singer and Candall, 1995; Singer, 1991). Seitz serves as Chairman of SEPP's Board of Directors, which also included Nierenberg up until his death in 2000. Several of the Marshall Institute physicists (Seitz and Happer) have also supported Singer in other ways, e.g. by endorsing Singer's writings and his credentials as a scientist (Seitz, 1997; Singer, 1997). Singer has also served as advisor to the government, albeit not at the level of the Marshall Institute trio whose unusually remarkable scientific reputations he does not share.

Although they appear to embody formerly dominant paradigms in science and society, this should not be understood in terms of cultural determination; there is an inescapable element of individual choice and, hence, of agency in where they have come out on the climate issue. Apart from the important cultural and experiential factors shaping their positions on the issue, they have simply been disinclined to change their ingrained dispositions in line with more recent trends. The role of individual choice is reflected in the fact that other physicists of similar (albeit not identical) profile have embraced the environmental paradigm. A prime example of this is late Henry Kendall, Nobel Laureate and member of the same physicist elite as the Marshall Institute trio. Kendall, who died in 1999, was born in 1926 on the East Coast of the United States. He started his Ph.D. training in 1950 at MIT and obtained his Ph.D. one to two decades after the trio received their degrees. He did basic research in physics and was among the scientists who designed experiments to be performed on the Superconducting Super Collider. He is also said to have

[19]Upon reading a draft of the present article, one physicist personally familiar with a fair number of JASON scientists described the group as, on the whole, probably more liberal than conservative in its disposition. He also noted: "I would say that most of the Jasons, and their ilk in science, consider themselves 'entitled to some prestige', although there are also many scientists, even physicists, who are quite humble" (Robert Frosh, personal communication).

[20]Omitting acknowledgement of the political opposition, Singer writes "[N]uclear energy should have a bright future. Reactors, factory-built to a standard design, will reduce cost and increase safety. Uranium is plentiful and cheap, and likely to be so for many decades…" (Nuclear Energy Insight, 1995).

been a member of JASON for a period of 10 years, advising the Defense Department on defense issues, including nuclear technology.[21] Yet, by contrast to the trio, Kendall embraced the new paradigm related to science and the environment. He was co-founder and chairman of the Union of Concerned Scientists, through which he fought against nuclear technology and SDI, among other weapons technology. Kendall was a strong critic of the Reagan and Bush administrations on a variety of issues, including that of climate change; he advocated decisive policy action on behalf of global warming, despite recognition of scientific uncertainties (Chandler, 1990). Kendall embraced the paradigm of planetary vulnerability and considered scientists partly responsible for the "damage and risks that are now so apparent in such areas as environmental matters and nuclear armaments"[22].

The trio could, like some other physicists similarly trained in weapons research, have chosen to retool and reposition themselves in response to the changes in funding structure and in understandings of the relationships between science, technology, society and environment. Nierenberg and Jastrow became directors of earth science institutions, but they continued to value the earth sciences as inferior to physics and did not convert to impact science and the new paradigm.[23] Instead, they joined the backlash. It would seem that they did so to stem the changing tides, to defend deeply held values related to science and technology and to preserve the honor and prestige to which they felt entitled. Their actions bear the imprint of their personal histories and experiences, and associated evaluations of what is appropriate.

The case of the Marshall Institute trio sheds light on why age tends to decrease an individual's level of environmental concern while remaining, overall, a relatively weak indicator of environmental concern (Mohai and Twight, 1987; Van Liere and Dunlap, 1980); in the case of the Marshall Institute trio, age appears as a factor only in combination with other important contributing factors, including individual choice.

8. Conclusion

In the early 1970s, American environmental sociologists predicted that national efforts to solve widely perceived environmental problems would "run head-on into many traditional values and time-honored practices" (Dunlap et al., 1973). This paper confirms their prediction, revealing the role of associated struggles over meaning and values in US climate science and politics. In some respects Nierenberg, Seitz and Jastrow are representative of broader categories of which they are partly part. They share common characteristics with other physicists and with a particular subgroup of physicists and governmental advisors in particular, an older generation of elite physicists shaped by nuclear physicists. The Marshall Institute trio has lived through dramatic changes in popular attitudes towards science and the environment. Their engagement in US climate politics can be understood in part as a struggle to preserve their particular culturally and historically charged understandings of scientific and environmental reality, and an associated, particular normative order. The trio has found support for important dimensions of their worldviews and policy preferences within the backlash and among Congressional Republicans, but they must continuously contend with challenges to the privilege to which they had grown accustomed in science and government.

This article has sought to explain the trio in a non-deterministic manner, choosing instead to understand them in terms of multiple, overlapping factors, each of which serves as a "prism" through which to gain partial understanding into their involvement with the anti-environmental movement. The case study suggests the importance of life experiences, personalities, culture and politics for scientists' decision whether or not to accept invitations to work with the anti-environmental movement. The same extra-scientific factors affect the engagements of their counterparts on the environmental side, regardless of where one judges the preponderance of the scientific evidence to lie.

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[21] *Source*: anonymous reviewer of manuscript submitted for review to the journal Social Problems.

[22] (Henry W. Kendall—Autobiography, available at http://www.nobel.se/physics/laureates/1990/kendall-autobio.html (accessed 23 November 2007)).

[23] Nierenberg's statements during a Congressional hearing (US Government, 1996) investigating climate science reflect an oscillation in his discourse related to funding of climate science. This oscillation likely reflects tensions between his loyalty to basic and "production" science and his past imperatives as director of Scripps Institute of Oceanography, an institution that also produces "impact" science (including climate science). Nierenberg expresses support for climate science but, when pressed and asked to prioritize, retreats somewhat, acknowledging his preference for basic research. The 1995 hearing, which took place at the height of the Republican "Contract with America," was part of an effort among Republicans to reduce funding for climate science. The Chair of this Congressional meeting, Representative Dana Rohrabacher from California, associated climate science with "trendy science that is proposed up by liberal/left politics rather than good science" and referred to the theory of global warming as "at best unproven, at worst… liberal claptrap" (Applegate, 1995; Brown, 1996).

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