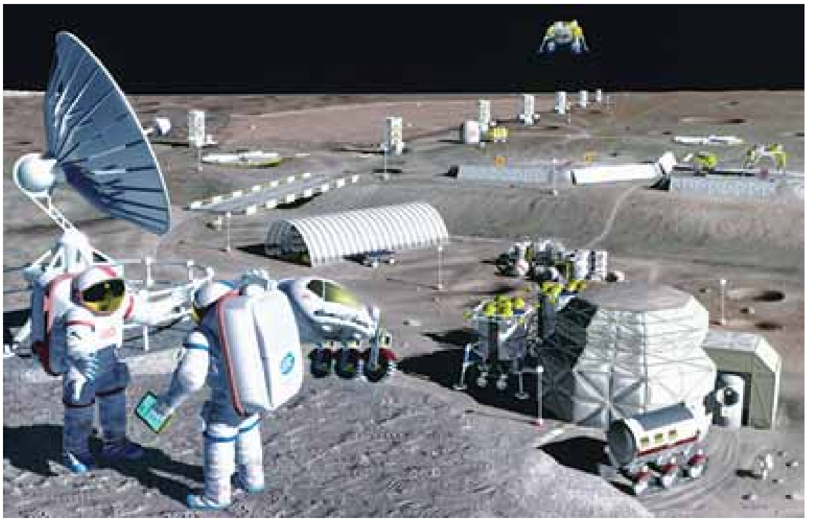
# China To Industrialize Moon; Realize Promise of Thermonuclear Fusion

by Creighton Cody Jones

While the economy of the United States stands at the verge of collapse, hobbling along under the dead weight of the London-Wall Street money system, China is on a trajectory upward, propelled by its orientation toward an "American System"-style, science-driver economic policy, and a defense of national sovereignty. China's dedication to the future development of mankind is exemplified by its commitment to elevate and upgrade its space program, to a mission of exploring, developing, and mining the Moon, with a special emphasis placed upon the ultimate use of the chemical isotope helium-3, which is found in relative abundance in the Moon's regolith (lunar soil), as a fuel for thermonuclear fusion-powered energy production—the next frontier in technology revolutions.



*China is leading the way into deep space, as can be seen in its manned space and lunar probe missions. Premier Li Keqiang described their purpose as "to explore the origin of the universe and mystery of human life; and second, to make peaceful use of outer space. . . ." Here, an artist's concept of mining (helium-3) on the lunar surface.*

By "American System," we mean the explicitly anti-free-trade economic policy that was fully developed by our first Secretary of the Treasury Alexander Hamilton, and has been employed by such great Presidents as Abraham Lincoln and Franklin Roosevelt. Under the American System, real wealth is measured not in terms of monetary values, but in terms of increased standards of living and quality of life, as this is expressed through the increasing of rates of increase of the productive powers of labor (i.e., increased power to transform nature), driven by the use of higher energy-flux density technologies.[1]

This is achieved through a government-directed, long-term credit policy, aimed at the promotion of front-end technology-driven, large-scale infrastructure projects, and science-driver national missions. In the history of the U.S., this policy has been typified by such projects as the Transcontinental Railroad, the Tennessee Valley Authority and Rural Electrification Project, the Manhattan Project, and the Apollo missions, to name a few. For China today, this means, at the science-driver level, a unified policy of vastly expanding its space program, while simultaneously progressing upward with the development of fusion power and related technologies.

This upshift toward the achievement of fusion power and industrial development of the Moon by China comes in the context of having already completed, in the last two decades, the largest dam in the world, the Three Gorges Dam, and having laid the greatest amount of magnetically levitated (maglev) high-speed rail of any nation. In addition, China has built hundreds of new

1. Jason Ross, "Energy-Flux Density: Global Measure of Economic Progress," *EIR*, Aug. 8, 2014.

cities in the past 30 years, and has committed itself to building hundreds more by decade's end.

China currently has 28 nuclear reactors under construction, and plans to more than triple its nuclear capacity by 2020; it has begun construction of the world's longest quantum-optics based communication line, from Beijing to Shanghai, to give further credence to its place as a world technology leader.[2] Furthermore, it announced, in May 2011, a policy to graduate 2,000 new fusion scientists and engineers by decade's end.

On an international level, China is playing a leading role in the motion of such multinational alliances as the BRICS, which at its recent summit (July 14-16, 2014) in Fortaleza, Brazil, announced the formation of a $100 billion "New Development Bank" (NDB), to be headquartered in China, for the purpose of financing infrastructure and development projects across the globe. The NDB is de facto a step toward supplanting the increasingly discredited IMF and World Bank on the international stage. The BRICS Summit has also provided the backdrop for a number of bilateral agreements among the BRICS member nations (Brazil, Russia, India, China, and South Africa), as well as participant Argentina, for the building of nuclear power facilities and other necessary infrastructure projects on multiple continents, with China playing a leading role. All of this provides the foundation for the development of a 21st-Century deep-space and fusion power economic platform.

While it is true that at the current moment, hundreds of millions of people in China remain in conditions of poverty, and much of the nation still suffers from severe underdevelopment, the intention and the direction are clear: China sees its future in the stars.

The question is: Will America join them?

## China's Moon Program and Helium-3

Civilizational progress must be defined by a scientifically lawful vision for the future, and at present, the visionary frontiers for a future-driven society are in the domains of 1) the mastery of processes at the level of the increasingly small, the sub-atomic—namely thermonuclear fusion, and 2) expanded power in the increasingly large, the cosmic level—that is the exploration and development of processes in deep space. Both domains, the subatomic and the cosmic, are unified in that they require mankind's increased control and utilization of principles of much higher energy-flux density than those in use today.

Currently, China is taking a lead role in demonstrating a commitment to this kind of future orientation in space and energy, as a single, unified perspective. This is evidenced by the fact that, for example, the government has recently appointed a sole individual, Xu Dazhe, as, simultaneously, the director of three agencies: the China National Space Administration (CNSA), the China Atomic Energy Authority, and the State Administration for Science, Technology and Industry for National Defense, thus ensuring a unification of intention and direction for the space program and nuclear science.

China's intentions for the future have been further elaborated in discussions among people close to the space-science community, particularly remarks made since China's recent successful completion of its first soft landing on the Moon, which took place on Dec. 14, 2013, with the Chang'e-3 space capsule, and the deployment of its Yutu Moon rover. Famed Apollo 17 astronaut and former U.S. Senator Harrison Schmitt, following the Chinese Moon landing, said, "China has made no secret of their interest in lunar Helium-3 fusion resources. . . . In fact, I would assume that this mission is both a geopolitical statement and a test of some hardware and software related to mining and processing of the lunar regolith." This is an area of knowledge that Schmitt knows well, having penned numerous papers and books on the prospect of lunar development and helium-3 mining, and having worked closely with the group at the University of Wisconsin which is developing helium-3 fusion technologies.

Reflecting the truth of Schmitt's assessment are the words of the "father of the Chinese lunar program," Ouyang Ziyuan, who began lobbying the Chinese government for a Moon program in the 1990s, and was finally rewarded in 2004 with the announcement of the China Lunar Exploration Project (CLEP), called the Chang'e Project, of which he became the first chief scientist. Ouyang said in a recent interview, "The Moon has huge reserves of metals such as iron," and that "helium-3, an isotope of the element helium, is an ideal fuel for nuclear fusion power, the next generation of nuclear power. It is estimated that reserves of helium-3 across Earth amount to just 15 tons, while 100 tons of helium-3 will be needed each year if nuclear fusion technology is applied to meet global energy demands. The Moon, on the other hand, has reserves estimated at between one and five million tons."

2. In a similar direction, the newly elected President of India ran on a platform of building new high-tech cities throughout the country.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*Ouyang Ziyuan, the "father of the Chinese lunar program," began lobbying the Chinese government for a Moon program in the 1990s, and was the first chief scientist of the Chang'e project. He said that, beyond the Earth, "we also need to know our brothers and sisters like the Moon, its origin and evolution and then from that we can know about our Earth." Above, the Change'e-3 rover on the Moon, December 2013.*

In addition, Ouyang stated, in a BBC interview of Nov. 29, 2013, that "The Moon is full of resources—mainly rare Earth elements, titanium, and uranium, which the Earth is really short of, and these resources can be used without limitation.... There are so many potential developments—it's beautiful—so we hope we can fully utilize the Moon to support sustainable development for humans and society."

Ouyang identified three motivations for going to the Moon: "First, to develop our technology, because lunar exploration requires many types of technology, including communications, computers, all kinds of IT skills and the use of different kinds of materials. Second, in terms of the science, besides Earth we also need to know our brothers and sisters like the Moon, its origin and evolution and then from that we can know about our Earth. Third, in terms of the talents, China needs its own intellectual team who can explore the whole lunar and solar system—that is also our main purpose."

These stated motivations underscore the recognition on the part of China of the role that science-driver programs play in expanding the technology and growth of the nation as a whole. This is something that was once better understood by government layers in the U.S., who would often quote the fact that the Apollo missions yielded a 10-to-1 return on investment, from technological spin-offs and increased production capabilities, as well as firmly establishing many high-tech industrial firms.

## Preparing for a Manned Mission

Rightfully declaring the Chang'e-3 mission a success, despite a glitch in the Moon rover Yutu's circuitry, China is currently putting forward a clear statement of the next steps in its Lunar Exploration Program.

Chinese scientists and engineers are working on designs for a lunar base that will include "new energy development and living space expansion," according to a manager of the Chang'e-3 spacecraft, speaking at the Shanghai Science Communication Forum, as reported in *Peoples' Daily*. Zhang Yuhua affirmed that China's lunar sample return mission, Chang'e-5, is now scheduled for 2017, an acceleration of the original timetable, because of the success of the current mission. He stated that the interim launch of Chang'e-4 will not be a repeat of the current mission, but will incorporate some of the new technologies needed for the highly complex later sample return. Returning the planned five pounds of samples of lunar soil and rocks will allow a detailed analysis of the Moon's minerals, chemistry, and other characteristics, which is a necessary step to precede sending people there. Zhang described the activity of a lunar base as setting up agricultural and industrial production, producing medicines in the vacuum environment, and "energy reconnaissance."

Add to this, the long-term intentions of the lunar program as stated by Luan Enjie (a senior advisor to China's lunar program) who told state media that the ultimate aim was to use the Moon as a "springboard" for deep space exploration, which many experts acknowledge would require a base on the lunar surface.[3]

While it has not been made official by the government, it is clear to many that a manned landing on the Moon will one day appear on the horizon for the Chi-

3. http://phys.org/news/2013-12-moon-pie-sky-china -experts.html

nese, as part of their continued expansion of manned space exploration. Recently, in an interview with *Science,* Chinese premier Li Keqiang spoke about the manned program, saying, "China's manned space and lunar probe missions have a twofold purpose: First, to explore the origin of the universe and mystery of human life; and second, to make peaceful use of outer space.... Peaceful use of outer space is conducive to China's development. China's manned space program has proceeded to the stage of building a space station, and will move forward step by step.... As human life is precious, we will start with robotic exploration before gradually expanding manned space exploration. Space is all too mysterious. We need to take risks, but not at the cost of human life when conditions are not yet right."

Additionally, there have been numerous articles in the Chinese and international press about the manned Moon mission. *People's Daily,* for example, quoted Zhang Yuhua, who said, "The manned lunar landing has not yet secured approval from the national level authorities, but the research and development work is going on."[4] An article recently published by Australian space analyst Dr. Morris Jones cites well-reasoned evidence that China is planning an unmanned circumlunar flight for the near future, which is a necessary precursor mission for an eventual manned landing.[5]

The reality of this potential is further commented on by a leading British space scientist, Prof. Richard Holdaway, of the government-funded laboratory RAL Space, who has extensive experience working with China. He believes that China could have astronauts on the lunar surface by 2025. "They started from a long way back, but now they're catching up fast—they want to monitor what's happening on the ground, they want to be part of the analysis of climate change and a much bigger program looking at the Moon for mining or as a staging post to other parts of the Solar System."[6]

More recently, China has made a number of announcements which concern both near- and longer-term plans for the Moon. For example, China will conduct simulation tests on the return to Earth of the Chang'e-5 lunar probe at the end of this year.

The longer term goals are made clear by the report of the completion of a 105-day test of the "Lunar Palace 1" (Permanent Astrobase Life-support Artificial Closed Ecosystem), a facility created to test the requirements for a life-supporting Moon base.

As reported on us.news.cn on June 26, "The three 'Moon dwellers' drank recycled purified water, ate worms and food they grew themselves, conducted experiments, and chatted with their family on the internet in the enclosed capsule from February 3 to May 20." Chief designer and lead scientist, Liu Hong, commented, "Lunar Palace 1 is different from Biosphere 2, an Earth systems science research facility in the U.S.

"Biosphere 2 is a duplication of the living environment on Earth, which is a failure we did not want to repeat. The system we made was directed towards the needs of humans. We carefully chose what plants, animals, and micro-organisms would be best included in the ecosystem.

" 'Many foreign experts think building a space base cannot be achieved in the near future, so they do not put many resources into research in this field,' says Liu, 'But the length of time needed to understand the complexity of an eco-system is why scientists should start experimenting now.' Liu says, 'it is necessary to build two mini Lunar Palace 1 systems—a monitoring station on the Moon and one on Earth—so the two sets of data can be compared.' "

Mars is also a destination that China has its eyes on, and it is deep into the development phase of a mission to return samples from the Red Planet, with plans to land a probe on Mars in 2020, and to return with samples in 2030. China's "Mars-Plus" plan was further elaborated by Ouyang Ziyuan, at the opening ceremony of the 22nd International Planetarium Society Conference held in Beijing on June 24, where he stated, "China's goal for space exploration is the Solar System." He added that future exploration in the Solar System will include the search for extraterrestrial life, the origin and evolution of the Solar System, solar eruptions, and other phenomena. Ouyang told *People's Daily* that another important goal of the Mars mission is to detect solar systems beyond Earth's reach, and to compare the origins of Earth-like planets with the formation of our Solar System. The most ambitious project of the Chinese space agency is that they hope to "recreate" a planet, based on information obtained through exploration. [7]

4. Jan. 8, 2014. http://english.peopledaily.com.cn/202936/8506408.html
5. http://www.spacedaily.com/reports/Chinas_Fast_Track_To_Circumlunar_Mission_999.html
6. http://www.bbc.com/news/25141597

7. "China To Search Mars for Aliens and 'Recreate Planet,'" *People's Daily* Online, June 26, 2014. http://english.peopledaily.com.cn/n/2014/0626/ c98649-8747066.html

## International Collaboration: China and Russia

In the wake of a June 2014 landmark deal signed between Russia and China for the export of $400 billion in natural gas to China, there has been an intensification of collaboration between the two countries in numerous areas, including space science. As reported in Ria Novosti on June 30, 2014, at the First Russia-China Expo, Russian Deputy Prime Minister Dmitri Rogozin said that Russia is ready to work with China to explore the Moon and Mars. "If we talk about manned space flights and exploration of outer space, as well as joint exploration of the Solar System, primarily the Moon and Mars, we are ready to go forth with our Chinese friends, hand in hand," he said. Rogozin believes that Russia and China could work together to create spacecraft, "a joint base of radio components independent from anyone," as well as cooperate in cartography and communication.


*The deepening of collaboration between Russia and China was recently given voice by Russian Deputy Prime Minister Dmitri Rogozin, who said, "If we talk about manned space flights and exploration of outer space, as well as joint exploration of the Solar System, primarily the Moon and Mars, we are ready to go forth with our Chinese friends, hand in hand," Here, Presidents Putin and Xi shake hands on a huge natural gas deal in May.*

The Russian Federal Space Agency (Roscosmos) and its Chinese counterparts also signed a memorandum of understanding "on cooperation in global navigation satellite systems." Rogozin said that the Russian navigation system GLONASS and the Chinese Beidou will complement each other.[8] China is additionally moving forward on space collaboration with India and the European Space Agency as well. In fact, the Chinese Academy of Sciences (CAS) and the European Space Agency (ESA) are co-hosting a workshop for "planning for a joint scientific space mission this coming September in Denmark.[9]

### Contrast with the U.S. Space Program

The image of China with a clear mission and order of operations for its space program contrasts sharply with the picture one finds in the United States, which has seen NASA, under austere budget constraints and whimsical shifts in mission orientation and established goals handed down by policymakers, groping to maintain its role as the world leader in space. Moreover, current U.S. law bans collaboration between America and China on space exploration and related technology development.

At the same time, the budget for fusion research, the other side of the advanced technology coin, has not been funded up to necessary levels, and has been further slashed in recent proposals from the Obama White House, leaving the domestic program in an anemic state. This policy leaves the future of the U.S. program much in doubt, as the high-skilled work force continues to diminish in size, and the average age of skilled scientists and engineers continues to climb towards retirement age.

A brief sketch of the recent history of the fate of the U.S. space program, and parallel changes in the fusion energy policy, suffice to illustrate the sputtering trajectory of the United States' scientific and economic future.

As recently as 2005, NASA was operating with a comprehensive roadmap toward developing the technology and capability to return a four-man crew to the surface of the Moon, targeting the icy south pole as an optimal destination. The Constellation program was to replace the Shuttle-centered program, slated to be mothballed in 2010. The shutdown of the Shuttle program was to create the "savings" to fund Constellation

8. The U.S. has refused to allow Russia to set up GLONASS ground stations here, even though we have a few in Russia, which is one reason they are anxious to do this with the Chinese.

9. http://sci.esa.int/cosmic-vision/54130-2nd-workshop-on-planning-for-a-joint-scientific-space-mission/


*As China surges ahead in space science, the U.S., once the premier spacefaring nation, has seen its space program whittled away to almost nothing. NASA's Constellation program, for example, was doomed by austerity, and lack of funds to maintain even key aspects at life-support levels. Shown: the Ares 1 Upper State Hydrogen Dome Weld (July 2009), part of the Constellation program.*

without increasing NASA's overall budget. Though it was known that this would create a time-gap where no American vehicle would be capable of getting astronauts and supplies to the International Space Station, it was accepted in the context of the U.S. embracing a greater mission.

A selection of typical news quotes from that 2005 period gives an indication of what official U.S. policy was, and also reflects where the Chinese space policy discussed above has its origin.

"NASA briefed senior White House officials Wednesday on its plan to spend $100 billion and the next 12 years building the spacecraft and rockets it needs to put humans back on the Moon by 2018" (September 2005).[10]

"NASA's plan envisions being able to land four-person human crews anywhere on the Moon's surface and to eventually use the system to transport crew members to and from a lunar outpost that it would consider building on the lunar south pole, according to the charts, because of the region's elevated quantities of hydrogen and possibly water ice."[11]

"One of NASA's reasons for going back to the Moon is to demonstrate that astronauts can essentially 'live off the land' by using lunar resources to produce potable water, fuel and other valuable commodities. Such capabilities are considered extremely important to human expeditions to Mars which, because of the distances involved, would be much longer missions entailing a minimum of 500 days spent on the planet's surface."[12]

Whatever one may think of the specifics of the Constellation program plan,[13] it was nonetheless an ambitious and robust strategy relative to the period that followed the shutdown of the Apollo Program. Yet, even at that point, we could have been engaged in a crash program to develop nuclear and thermonuclear propulsion systems, and expanding an otherwise shrinking economy with a science-driver program based on such technologies.

The case of Constellation exemplifies the folly and peril of trying to realize a decades-long mission within the constraints of annual budgets, and without the political leadership to make it happen.

With cost overruns, and in an environment of austerity, NASA was lacking the funds needed to meet its established deadlines, and to maintain even key aspects of Constellation at life-support levels.

As it stood, the Bush Administration had never provided adequate funding for Constellation, as has been

10. See more at: http://www.space.com/1553-nasa-unveil-plans-send-4-astronauts-moon-2018.html#sthash.ZTc50pqd.dpuf

11. See more at: http://www.spacenews.com/article/nasas-moon-and-mars-plan-echoes-apollo-approach

12. See more at: http://www.space.com/1553-nasa-unveil-plans-send-4-astronauts-moon-2018.html#sthash. ZTc50pqd.dpuf

13. Which can be found here: http://www.nasa.gov/mission_pages/constellation/main/index2.html

the case with all NASA programs, from Apollo to the Shuttle, in which the ultimate cost of achieving something that had never been done before, could not be determined. In 2009, the Obama White House set up the Augustine Commission to review the status of NASA's human space-flight program. The conclusion was that, to keep Constellation on track would require an additional $3 billion per year. The response from the Obama White House was to shut it down. As a result, all that remained was some blustering about going to Mars, and a compromise "heavy lift" rocket, the Space Launch System (SLS), with no clear mission in site. This is not to take away from the value of the upcoming missions of Orion, but relative to where we were 40 years ago, one could hardly say that it represents a revolutionary leap forward.[14]

The Orion capsule is set to make its first unmanned test flight, atop a Delta IV rocket, sometime after December, with the intention to "evaluate launch and high speed reentry systems such as avionics, attitude control, parachutes and the heat shield," according to NASA. So, more than 40 years after we last landed on the Moon, the U.S. is again embarking on a deep-space mission, though a clear long-term pathway has not been established. Orion is ultimately intended to be launched atop the SLS, with phase I to be tested in 2017, with a 70-ton payload capacity, to be followed some time later by the phase II SLS with a 130-ton capacity, which is touted as being the most powerful rocket ever developed, finally surpassing the Apollo Saturn V.

Although the fact is that the Orion and SLS combination has advanced capabilities, above the Saturn V rocket and the Apollo Command Module, and the fact that it has a deep-space capability that the Space Shuttle was never designed to achieve, nearly 50 years beyond our first deep-space mission, nearly two generations, we are still relying on chemical rocket technology. The problem is better understood when viewed in the context of NASA's nuclear rocket program (NERVA), which was canceled in 1973, despite its meeting all of its development goals up to that point. Also, laboratories in the U.S. have carried out over 40 years of research and design for the development of fusion-powered rockets, with near-zero government funding and promotion. This failure to adequately support next-generation technology has thus ensured that no principled advance has been made in the area of deep-space propulsion.[15]

Some sense of where the U.S. space program currently stands can be gleaned from a recently released report from the National Research Council (NRC),[16] which was the result of a congressionally mandated 18-month study of the future of human spaceflight. The report states that to continue with the currently budgeted path "is to invite failure, disillusionment, and the loss of the longstanding international perception that human spaceflight is something the United States does best." Said Mitch Daniels, the former Indiana governor and co-chair of the committee, "Absent a very fundamental change in the nation's way of doing business, it is not realistic to believe that we can achieve the consensus goal of reaching Mars."

The NRC report presented three potential pathways to Mars, with the two most favorable involving a return to the Moon. It states that a lunar landing and habitat development would be instrumental in developing technologies to be later used in a Mars mission. In contrast, the report saw the third path, which includes the currently ill-defined asteroid capture and return mission, as least favorable. The report stated that the asteroid capture mission involved the development of a large number of "dead end" technologies that have no application for a future Mars landing. The committee also raised safety concerns with the current pathway, stating that it "cannot provide the flight frequency required to maintain competence and safety."

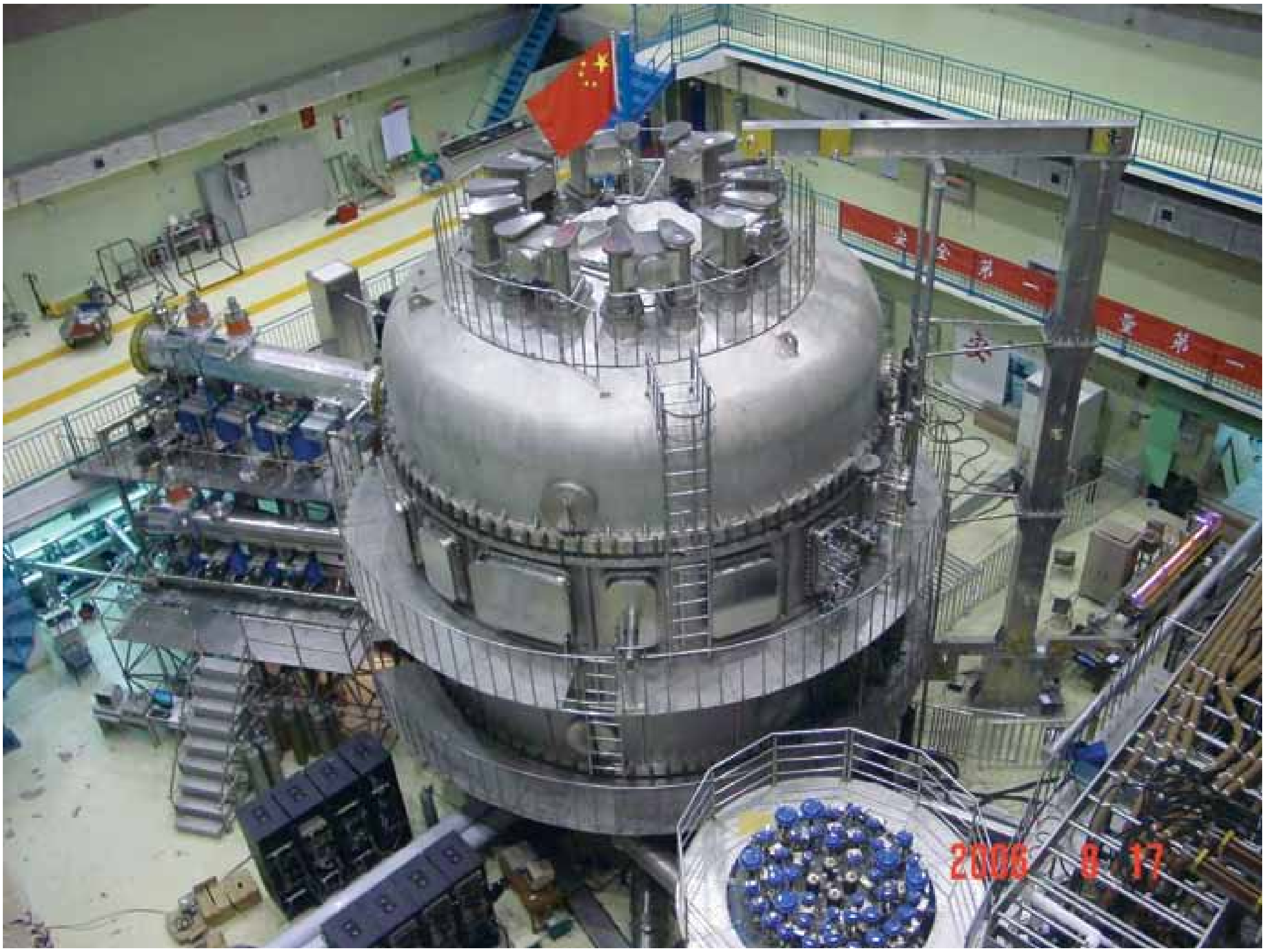
## China's Fusion Program

At the top of China's long-view intention is the development of thermonuclear fusion power. Not only is China a contributor to the ITER (International Tokamak Experimental Reactor) project, but it is pushing ahead with its own tokamak reactor program. In fact, the Chinese have, with their EAST (Experimental Advanced Superconducting Tokamak) reactor, a higher-level tokamak than any found in the U.S. As it is, the EAST utilizes superconductive magnets (which no reactor in the United

14. http://www.nasa.gov/content/five-things-we-ll-learn-from-orion-s-first-flight-test/index. html#.U6I_1_ldXCc

15. Ion thruster technologies, which do tap into atomic properties, are, however, limited in application to low-power requirement missions.

16. http://www.washingtonpost.com/national/health-science/nrc-human-spaceflight-report-says-nasa-strategy-cant-get-humans-to-mars/2014/06/04/e6e6060c-ebd6-11e3-9f5c-9075d5508f0a_story.html




ITER

*China's Eperimental Advanced Superconducting Tokamak (EAST), above, was the first fully superconducting tokamak in the world, and is today, a higher-level tokamak than any found in the U.S.*

States currently does), which gives it a superior capability in magnetic confinement strength.

Additionally, on May 19, Chinese scientists at the Institute of Plasma Physics completed a 20-month upgrade to their superconducting EAST tokamak, and will soon begin their 2014 experiment. The goal of this year's experiments will be to extend the duration of fusion production to more than 400 seconds, working toward steady-state operation of a fusion machine.

China is also well on its way to developing an inertial confinement fusion (ICF) facility comparable to the laser fusion facility at the National Ignition Facility (NIF) at Livermore, Calif. Named Divine Light 3 (SG-III), this facility is designed to utilize 48 lasers to compress an isotope fuel pellet to ignite fusion reactions. Although the facility is currently only in the target design experimental phase, the next phase, Divine Light 4, is scheduled to be running by 2020, with the intention of going for ignition of actual fuel.

In conjunction with this, in the process of building up its laser arsenal, China is developing a top-of-the-line, automated robotic machining capability for the construction of such lasers, which will give them a mass laser production capability, which can be applied to other sectors of the productive economy.

Meanwhile, in the U.S., there continues to be a counter-productive penny-pinching approach to fusion funding.

Annual budgets, which include the U.S. commitment to ITER, have fluctuated between $350 and $500 million over the last few years. Compare this to the fact that in the period since 2006, the U.S. has spent over

$100 *billion* in subsidies and tax-breaks on low-energy-dense "renewable energy." This meager budget for fusion has resulted in unnecessary, and unproductive, competition for money among equally worthy and necessary programs within the fusion community. Just to give a flavor of the squabble over a relative pittance, look at the 2014 fusion budget, which cuts $22 million from the previously budgeted U.S. allocation to ITER, and diverts it into MIT's tokamak program to keep it going for two more years; the program otherwise faced shutdown after this year, according to the previous 2013 budget.

In reality, both projects are equally necessary and worthy of funding, and should be part of a hyper-accelerated program to realize the potentials of fusion power. Compare this example of the yearly budgeting approach currently employed in the U.S., to the approach taken by South Korea, the other nation operating a superconductive tokamak reactor (KSTAR),[17] and one that has experienced a "miracle" rate of economic growth in the last half century, where fusion budgets are guaranteed by law until 2040.

First-hand reports to this author reflect an unfortunate and common trend in the U.S. toward reducing its fusion commitment. At the University of California San Diego, for example, one of the few universities in the U.S. with a fusion energy program, funding cuts are forcing the science department to shut down the division that deals with the engineering and construction of fusion reactors, thus limiting work to basic plasma research only. This is done despite the fact that nearby San Diego State University is at the center of what was the Ares program, a Department of Energy-funded program that functions to facilitate activity among, and provide a platform for dialogue and data-sharing between, the fusion reactor R&D projects that operate at various labs throughout the United States.

Another example which is indicative of the state of affairs regarding fusion in the U.S., is the status of the National Compact Stellarator Experiment (NCSX) at the Princeton Plasma Physics Laboratory. This new plasma-confinement experiment, known as a stellarator design, was developed to offer an alternate path to fusion energy. The design would produce a kind of twisted ring-shaped plasma, carefully crafted to integrate the demands of 24 different parameters, and take advantage of the natural contortion tendencies of the plasma. At the point at which the parts had been completed, and only required assembly, the program was shut down, due to lack of funding. Of the $100 million needed to complete construction, China offered half, if the U.S. could find the rest. After the U.S. could not, China then offered to complete the project in China. This offer was refused based on a glimmer of hope that the funding might one day appear in the U.S.[18]

## A Shining Example: U.S.-China Collaboration

Fusion research is an area that currently expresses best what the future might hold, were there to be a true cooperation among nations.

As it is, a number of the most progressive breakthroughs in the fusion world have come about as a direct result of U.S.-China collaboration. These include the record-setting achievement of a pulse-length confinement time of 30 seconds for an H-mode plasma at the Chinese EAST (Experimental Advanced Superconducting Tokamak). This record result was achieved by Chinese scientists beaming a microwave frequency into the plasma, which reshaped the magnetic field lines that confine the plasma, thus reducing the instabilities. This new technique was combined with one developed by fusion scientists at Princeton Plasma Physics Laboratory, which is to coat the plasma-facing wall of the tokamak with a lithium metal, which absorbs the stray particles of plasma, stopping them from disrupting the fusion process.

Another collaborative advance was achieved with the Doublet III-D tokamak at General Atomics in California, where U.S. scientists, along with visiting plasma scientists from the Chinese EAST project, conducted experiments with the DIII-D tokamak that demonstrated that the plasma itself generated a current that was more than 85% of the current in the plasma. This large "bootstrap" current will significantly reduce the amount of external power required for confinement of the plasma. Dr. Andrea Garofalo, General Atomics scientist and co-leader of the joint experiment, commented

17. "Fusion in Korea: Energy for the Next Generation," *EIR,* Dec. 4, 2009. http://www.larouchepub.com/eiw/public/2009/2009_40-49/2009_40-49/2009-47/pdf/28-35_3647.pdf

18. For a deeper understanding of the sabotage of fusion, which has been caged in the "fusion is always 30 years away" cell for the last 30 years, see Megan Beets, "Who Stole Fire from Mankind: The Suppression of Fusion," *21st Century Science & Technology* (offprint), May 2014. http://www.21stcenturysciencetech.com/Articles_2014/Suppression_Fusion.pdf

Transrapid

*China is currently the only nation in the world utilizing maglev for commercial transport. This technology, like many others, originated in the U.S. (and Germany), where its development has screeched to a halt.*

on this, saying, "It is often said that a plasma with a high fraction of self-generated (bootstrap) current would be difficult to control. However, these experiments show that a high bootstrap fraction plasma is very stable against transients: the plasma seems to 'like' a state where a large fraction of the current is self-generated."[19] It is likely that insights gained from this experiment with the DIII-D tokamak represent part of what contributed to the previously mentioned breakthrough at the more powerful EAST reactor in China. These breakthroughs and results are likewise likely to contribute further toward the larger international collaboration being done with ITER.[20]

Ironically, much of the high-end technology being developed by China, and other nations for that matter, has its origin in the United States. The bulk of that technology comes out of the scientific and productive potential built up under the leadership of Franklin Roosevelt, and in the echoes of his legacy, as under the Eisenhower and Kennedy administrations, with, for example, the Manhattan Project, Atoms for Peace, and the Apollo missions. It was out of these projects that the world got nuclear power, atomic medicine, and deep-space exploration capabilities, with leading scientists from around the world emigrating to America to participate in the advancement of human progress.

Likewise, the next generation of infrastructure technology, in particular, transportation and energy, has also been heavily borrowed from the U.S. For example, maglev trains, which China is currently the only nation in the world utilizing for commercial transport (Japan is currently building one as well). Maglev is based on a technology originally developed by U.S. and German engineers. The latest design, using maglev trains traveling inside evacuated tubes that can reach speeds of up to 4,000 mph, and which was recently tested at China's Applied Superconductivity Laboratory of Southwest Jiaotong University, originates from the Brookhaven National Laboratory in New York, where it was patented in the 1960s.

Also, China's record-setting superconducting tokamak reactor EAST is based on designs (and scientists) from the Princeton Plasma Physics Laboratory, specifically the TPX (Tokamak Physics Experiment), which was designed to be the next generation of tokamak experiment, but was subsequently dropped in the U.S. due to lack of funding.[21]

## Where Is the National Commitment Today?

In addition to analyzing statements regarding ambitious projects and grand visions for the future, we need to look at where the actual physical and economic investment is being directed, as well as analyzing trends in terms of changing rates of investment. One

19. Read more at: http://phys.org/news/2013-11-plasma-self-control.html#jCp

20. "India Looks to Next Energy Frontier: Fusion Power," *EIR*, June 6, 2014. www.larouchepub.com/other/2014/4123india_frontier_fusion.html

21. "Interview: Dr. Yuanxi Wan: China's Ambitious Path to Fusion Power," *EIR*, March 11, 2011. http://www.larouchepub.com/eiw/public/2011/eirv38n10-20110311/46-54_3810.pdf

general area to look for an indication of economic direction is R&D spending. A December 2013 article in *R&D Magazine* states: "China has increased its R&D investments by 12% to 20% annually for each of the past 20 years; while at the same time, U.S. R&D spending increased at less than half those rates. As a result, China's investment is now about 61% that of the U.S., and continuing to close. At the current rates, China's commitment is expected to surpass that of the U.S. by about 2022, when both countries are likely to reach about $600 billion in R&D. China is investing heavily to create an innovation infrastructure that will allow it to develop, commercialize and market advanced technology-based products, moving beyond its established position as a low-cost location for manufacturing."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*China is playing a leading role in such multinational alliances as the BRICS, which, at its July 2014 Summit in Brazil, announced the formation of a $100 billion "New Development Bank" to be headquartered in China. Here, the leaders of the BRICS nations join hands at the Summit. Left to Right: Russian President Putin; Indian Prime Minister Modi; Brazilian President Rousseff; Chinese President Xi; and South African President Zuma.*

The article goes on to say that, as a result of this policy, "China's middle class will expand from 35% to 75% over the next 10 years—a demographic statistic that reflects economic growth and, to some extent, an innovation-enabled society." The article does go on, however, to state that at present, "global researchers surveyed still consider the U.S. superior to China in basic and applied R&D," and that "U.S. industrial, academic and government R&D are also viewed more favorably than Chinese counterparts."

Nonetheless, the direction is clear.

Also, China's current lag behind U.S. capabilities is being compensated for by the fact that, "about a third of China's advanced R&D is pursued in collaboration with U.S. research organizations, and about a quarter in collaboration with European research organizations."

## Economics as Nation-Building

When we say that China is moving with an American System-approach to economics, we refer to the kind of credit-expansion policy, to the tune of $10 trillion over the past six years, being directed towards high-technology infrastructure growth.

This is something that has recently been spotlighted and discussed by a top economic advisor to Russian President Vladimir Putin, Sergei Glazyev, who, in a May 12, 2014 interview with the Russian financial newswire rbcdaily.ru said: "During the recovery of the Chinese economy, currency emission rates were exceptionally high. It was the same during the Japanese economic miracle.... If currency issue is given away to banks for speculation, then comes inflation. If it is for refinancing of the real sector and investment in the modernization of scientific and technical potential, it is anti-inflationary."

This is precisely the case with China, for its currency emission since 2008 has indeed been well over $10 trillion, three times the Fed's total, yet without the level of asset inflation that we find in the West. China's currency emission policy has been ritually denounced by prominent British economic writers as guaranteeing a global crash, hyperinflation, etc. On the contrary, as noted by Glazyev, this issuance has been directed as credit toward the industrial sector, as opposed to speculation, to the effect that now the Chinese are leading the world in the production of high-speed rail, as just one example of their industrial transformation.

This is in the spirit of the kind of policy employed by Abraham Lincoln, for example, in the financing of the Transcontinental Railroad during the Civil War, made possible by his Greenback policy, which itself was an expression of the revolutionary concepts of Alexander Hamilton as he expressed in his reports to Congress on national banking and manufactures.

Add to this the physical investment being made on the part of China into the continent of Africa, where China is planning another 80,000 km of internal high-speed rail by 2020. In Abuja, Nigeria, on May 8, speaking at the World Economic Forum for Africa, Prime Minister Li proposed connecting all African capitals by high-speed rail, with financing from China and no political strings attached, according to *China Daily.*

Li said China and African countries would jointly launch high-speed railway technology R&D centers while cooperating on railway planning, construction, and operation. China will also help with African highways and airports, and is adding a new $10 billion credit line for Africa, as well as $20 billion already offered, and will increase the China-Africa Development Fund by $2 billion, to a total of $5 billion. "History and reality make clear to all: China's development gives opportunity to Africa; Africa develops, and China also benefits," Li said.

Most recently, China is moving to concretize agreements to set up an Asian Infrastructure Investment Bank (AIIB) with offers of participation to India, among a number of other nations. As reported by the *Financial Times* Beijing correspondent, "China is expanding plans to establish a global financial institution to rival the World Bank and the Asian Development Bank. In meetings with other countries, Beijing has proposed doubling the size of registered capital for the proposed bank to $100 billion," and, "Most of the funding for the lender would come from China and be spent on infrastructure projects across the region, including a direct rail link from Beijing to Baghdad."

China and India have already made public statements about collaboration in space, as have Russia and India, who already have a decade of collaboration in space. Such collaborative efforts would only be strengthened by the joining of India, which currently has observer status, to the Chinese- and Russian-led Shanghai Cooperation Organization (SCO), a political, economic, and military forum for Eurasian nations; not to mention the ties being forged among these nations through the BRICS summit.

Add to this the multi-billion-dollar agreements between China and Argentina for China to export locomotives and build high-speed rail there, financed by the China Development Bank. In addition to this, in the wake of the BRICS agreements, new deals have recently been signed to send nuclear components to Argentina from China.

So China is positioning itself to be a world leader in manufacturing and export of heavy capital goods, and is quickly developing a robust domestic machine-tool capability.

## Looking to the Future

The common adage that the progress of the Apollo program, or the massive industrial and technological build up of the U.S. in times past, was singularly and fundamentally driven by competition among powers during periods of hot and cold war is simplistic folly. While international political concerns were, and are, a serious consideration, and often necessitated scientific advancement, this is not the soul of what moved us in the past, and it will not be the motivation that returns America to its role as a beacon of hope for the future. Our mission must again be focused on that which was truly at the heart of what drove us to our greatest heights, which was to achieve the moral scientific high ground for the common good of all mankind.

The space-race for example, is not a race for the sake of sport or geopolitical control; rather, it is keyed by a purpose to preserve the moral authority of this nation, and to do it in collaboration with those nations and peoples who also see a future for humanity that is guided by the creative light of the human mind, and the technologies that express it. To lift the whole of the human race to a standard of living and quality of life which affords to all an opportunity to develop and express their potential, and thereby make an immortal contribution to the whole of human history, is our mission.

We must be driven by a commitment to expand throughout the Solar System and beyond, the potentials of the creative mind. Today this is achieved by committing the U.S. to a wholehearted effort to realize the virtues of thermonuclear fusion and deep-space exploration, done in collaboration with Russia, China, and India. The grim alternative is world war, so this we must do. Who and where are the leaders that will make it happen?