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Legal aspects of human orbital and suborbital spaceflight: Some legal, medical and ethical considerations

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ABSTRACT

This paper explores the legal framework applicable to human orbital spaceflight and the legal issues arising from prospected suborbital spaceflight. The main legal, medical and ethical issues related to the selection procedure and certification of commercial spaceflight participants on the International Space Station as well as on other vehicles reaching space are analysed in the backdrop of existing international regulation and emerging national legislation for commercial spaceflight.

1. Introduction

Juri Gagarin was the first human who went into outer space. Other astronauts and cosmonauts followed and a new step in the development of human spaceflight was reached when Neil Armstrong stepped his feet on the Moon on 20 July 1969. A third dimension started when the first space stations – the Soviet Salyut (1971–86) and the American Skylab (1973–79) – were built as prototypes of human habitats in outer space. Since 1998, the International Space Station (ISS) – the biggest project of international cooperation in space – is orbiting the Earth. The ISS provides a unique field for scientific research and experiments and is planned to continue to be the space habitat for astronauts from the participating States until 2024 [1] Between 2001 and 2009, the ISS had not only trained professional astronauts, but also hosted private orbital visitors on board, who had paid to spend a short period of time on the ISS. So far, most space missions took not much longer than a few months per astronaut [2]. The only one-year long mission was successfully completed in 2016 by US astronaut Scott Kelly and Russian cosmonaut Mikhail Korniyenko and provided further data to confirm that the space environment is especially hostile to the human body. In outer space, humans are exposed to higher levels of radiation, zero gravity, and to living conditions in closed and small habitats. For humans in outer space, there is a total dependence on equipment and every small mistake or technical failure could lead to fatal consequences. The list of negative effects to the human body and health is long. It involves bone loss and associated kidney problems; eyesight problems; a difficult adjustment of the vestibular apparatus to gravity-free movement; a redistribution of liquids throughout the body and many other physical but also psychological effects which can be partially overcome through equipment, exercise, stamina and constant medical screening.

In more recent times, private enterprises have been offering commercial (so-called 'suborbital') flights for non-trained candidates who want to be exposed to zero gravity [3]. While there is no definition of the term 'suborbital flight', the main difference with orbital spaceflight is the fact that parabolic flights do not complete an orbit around the Earth. Nevertheless, they would allow persons on board to experience a few minutes of microgravity before heading back to Earth [4]. The vehicles used for these flights which aim at reaching an altitude between 80 and 110 km, cannot be sustained by the drag of air throughout their flight. Therefore, they do not fall under the definition of an aircraft [5] and arguably reach outer space [6]. As the legal status of such suborbital vehicles and the activities they are used for is yet unclear, attempts to determine whether air law, space law or a *sui generis* set of rules for suborbital activities should be applicable have been undertaken during the past years.

On the international level, dedicated working group and meetings have been organized by the International Civil Aviation Organization (ICAO), the United Office for Outer Space Affairs (UNOOSA), the International Law Association (ILA), the European Aviation Safety Agency (EASA) and the International Institute for Space Law (IISL) with the aim to and establish the regulatory issues concerning suborbital activities. Apart from definitional and delimitation matters, they include discussions on the requirements for authorization, licensing, insurance and supervision of suborbital activities and the interaction between national and international legal regulation. So far, only test suborbital flights have been undertaken.

With a few exceptions, e.g. the first manned orbital flight of Juri

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Gagarin in the Vostok capsule in 1961 and flights onboard the retired Space Shuttle which operated from 1981 to 2011, orbital human spaceflight has so far predominantly taken place on the ISS and has typically been performed by trained astronauts for non-commercial, scientific purposes.

Thus, human spaceflight can take place either onboard a vehicle orbiting around the Earth (orbital human spaceflight) or, following newer concepts of commercial (non-orbital) spaceflight, onboard a suborbital vehicle.

In the following, some medical, legal and ethical questions are raised with respect to suborbital flights as professional enterprises assert that this will be one of the prominent possibilities for human spaceflight in the future.

As we will see, the legal regime for these flights is somewhat underdeveloped since as of yet neither the relevant international law, nor national legislation regulate all relevant aspects of such activities. Questions of liability of the suborbital flight operator, of coverage of medical risks as well as of insurability of these flights are at stake.

This article will sketch out some thoughts without the intention to give a full picture of this research area which has, despite a number of publications on certain aspects of the topic, not yet been investigated to a full extent. First, a look at some main questions of commercial human space flights in the area of suborbital flights shall be taken (I.), then a brief overview on orbital human spaceflight (II.), and envisaged Mars colonies will be given (III.), some common issues for all types of human spaceflight will be formulated (IV.) and at the end, other legal aspects of human spaceflight will be highlighted.

2. Commercial non-orbital human spaceflight: Suborbital flights

As of yet, no legally binding definition of suborbital flights has been accepted by the international community. ICAO elaborated that “A suborbital flight is a flight up to a very high altitude which does not involve sending the vehicle into orbit.”[7]. Although this definition is not uncontested, one can take as a main characteristic of suborbital flights the fact that they do not complete an orbit and therefore only partly take place in outer space [8].

There are different technical concepts for suborbital flights as suborbital vehicles can be launched either vertically, from a launch pad, or horizontally, e.g. by using a carrier craft (a spaceplane) to bring them into higher altitude. Vertical takeoff/vertical landing (VTVL) suborbital vehicles use booster rockets and, unlike aircraft which take off and land vertically, they do not use the air for launch support but are launched like rockets.

Other concepts include horizontal take off/horizontal landing (HTHL). This model was built upon the mode of operation of spaceplanes such as the NASA Space Shuttle and the Soviet Buran Space Shuttle. These models also use rocket power and are first towed to the end of a runway before the vehicle is thrusted by rocket engines to reach higher altitude.

As is well known, different suborbital commercial projects have been under preparation since 2004 when the first publicly known project, Virgin’s SpaceShipOne, was launched. The successor composite vehicle SpaceShipTwo/White Knight Two was planned to offer commercial flights at $ 200,000 per passenger by 2009. However, after an unfortunate test flight in 2014 resulting in a crash, the loss of the vehicle and the death of one of the pilots, the planned passenger flights were postponed and are currently still in the testing phase. Another participant in an evolving suborbital business was XCOR, a US company founded in 1999 which undertook first test flights in 2001 and built a spaceport in Curaçao. Its VTVL Lynx reusable suborbital vehicle was planned to provide both touristic and payload delivery flights before the company filed for bankruptcy in 2017.

Suborbital vehicles are further developed by Blue Origin which was founded in 2000 by Jeff Bezos and flew the first test flights of its HTHL New Shepard vehicle. In 2015, New Shepard became the first suborbital vehicle to land successfully vertically and in 2016 it proved successfully its reusability. Masten Space, a US company founded in 2004, developed the Xaero reusable vehicle which is not planned to carry humans. UP Aerospace was founded in 2004 and develops space launch and flight test services but has not announced plans to carry humans on suborbital flights.

Early prognoses foresaw that suborbital flights will be operated on a regular basis with a rate of about 13,000 passengers per year by 2021 [9]. More recently, in October 2017, Richard Branson stated that his company would get the first passengers in space by the beginning of 2018 and signed a memorandum with the Public Investment Fund of Saudi Arabia for an investment of 1 bio. USD in Virgin Group’s space programmes [10]. However, the first commercial suborbital flight has still to take place.

As of yet, there is no clarity on the matter of applicability of international air law or general space law to such flights. However, on the national level, some regulation has already taken place. In the USA, the authorization and regulation of the launch, operation and reentry of suborbital flights when carried out by US citizens or within the US, has to be authorized and regulated by the US Federal Aviation Agency (FAA) through its Office of Commercial Space Transportation (AST) [11].

Interestingly enough, despite the expected development of human space flight, in the existing law there are no stringent legal requirements for the medical certification of flight participants. There are, moreover, only a few statistics which provide information on the effects of suborbital spaceflight to the not specifically trained human body and health of non-astronauts [12]. In terms of training, Virgin Galactic’s specific program for suborbital flight participants foresees a three-day training [13] while XCOR’s program foresees four days of tourists training [14].

It is not yet disclosed whether these companies see a necessity of an extensive pre-flight medical screening. Decisions are made on the fitness of the flight participants, but the critieria lie with the private launch operator. So far, there have not been any strict medical criteria for applicants included in the national legislation applicable to suborbital spaceflight.

Thus, the selection procedure of spaceflight participants is going to be decided by the private operator as no standardization has been provided for.. Moreover, there are some voluntary FAA Recommendations [15]. However, apart from the concept of the so-called “informed consent” which is applicable to suborbital flights carried out in the USA or by US citizens [16] and requires that the operator informs the flight space participants on the risks associated with the launch and reentry, no other binding rules have been imposed on suborbital operators.

Informed consent means that participants, fully informed about the risks of launch and reentry, must give their consent to undertake the flight. This can be seen as a contractual waiver on claims for damages to life and health and presupposes the ability of the spaceflight participant to make an informed decision. Competent persons generally mean mentally competent adults over age 21, in the US case. In the case of space flight, emancipated minors cannot give such informed consent, and parents or legal guardians are arguably also incompetent to give consent on behalf of minors for such a high level of risk for life and health. Furthermore, the informed consent must be given in written form and signed by the participant. These forms should use language that the participant can reasonably understand. Interpreters must be provided where necessary. No abbreviations should be used and the form should include the procedure, risks, benefits and alternatives to the examination. Any participant may revoke any consent to the physical examination at any time either verbally or in writing [17].

As to medical insurance, this might be privately provided for spaceflight participants, but, as can be seen, there is no mandatory requirement. The informed consent is so far important because from a legal point of view the transporting agency or the commercial