ADDRESSING MENTAL HEALTH IN PLANETARY SCIENCE. S. D. Vance[1], C. Elder[1], A. Hofmann[1], S. Howell[1], M. Milazzo[2], R. T. Pappalardo[1], J. L. Noviello[3,4], D. A. Patthoff[5], Z. Khan[6], J. Rathbun[5], J. Vertesi[7] and co-signers of the associated 2023 Planetary Science Decadal White Paper [1]. [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, [2]Other Orb LLC, Flagstaff, AZ, [3]School of Earth and Space Exploration, Arizona State University, Tempe, AZ, [4]NASA Goddard Space Flight Center, Greenbelt, MD, [5]Planetary Science Institute, Tucson, AZ, [6]Unafilliated, Pasadena, CA, [7]Princeton University, Princeton, NJ

Introduction: As NASA strives to be more inclusive by confronting institutional racism, gender inequality, and sexual harassment, and by recognizing sexual and gender diversity, it must also work to address a compounding crisis of mental health [1,2]. Concerns raised about the costs to mental well-being of our demanding academic environment preceded, and are now compounded by, the global pandemic. Here, we summarize the available evidence for a mental health crisis among academics. We describe how this problem intersects with and amplifies problems of equity, diversity, and inclusion. Addressing the problems is not just a matter of doing the right thing, it is a necessary step toward creating a more creative and effective workforce.

Our main finding is that NASA should invest in efforts to understand the scope and impact of mental health problems in its scientific workforce. NASA should address such challenges among its scientific workforce by funding intervention strategies, providing incentives to reward effective mentorship, fostering healthier work habits, and equitably supporting non-traditional work styles that may suit diverse individuals. To quote a recent article from Science magazine [3], "The entire academic community needs to tackle the systemic factors that likely contribute to mental distress. Institutions should implement adequate support systems for mental health. Principal investigators should lead by example in promoting their own well-being and the well-being of their trainees." Moreover, collaborators should be considerate of colleagues who might need a specific work schedule for undisclosed reasons.

In our language and description of symptoms described we have strived for consistency with the Diagnostic and Statistical Manual of Mental Disorders, 5th edition [4], but we emphasize that none of the authors of this paper has formal training in psychology or psychiatry. This abstract summarizes what we feel are the issues most impacting the scientific community, but we emphasize there is a broader scope of pressing topics that is described, also incompletely, in the associated white paper for the 2023 Decadal Survey [1].

Evidence for a mental health crisis among academic researchers: Studies revealing a high prevalence of anxiety and depression among a diverse sample of graduate students [5] point to a need for more comprehensive career development programs across institutions, to support awareness and management of mental health. Institutions providing such interventions may have competitive advantages over those that do not by attracting and retaining students, postdoctoral researchers, and faculty. The authors advocate for training programs pairing mental health professionals with faculty, administration, and department staff.

These impacts persist beyond graduate school under the compounding pressures of establishing a career [6]. Numerous blog posts by academics in recent years have highlighted the emotional toll of balancing the demands of personal life while building a research program and seeking tenure [1]. In the recent survey of the planetary workforce [7], the single most important item that negatively affects respondent's careers is the balance between their work and personal life.

Mental health as a cross-cutting theme: Causes and triggers of poor mental health are not fully understood, but risk factors include impoverished and traumatic upbringings, and membership in groups labeled as underrepresented. The extraordinary stress of academic life as a trigger for depression, anxiety, and burnout should not cause us to ignore other types of mental illness. The incidence of other types of mental illness such as personality disorders and psychoses together affect about 5% of the adult population, but little is known about the prevalence or impact of these illnesses among academics [6]. At least one recent study suggests a higher prevalence of schizophrenia and bipolar among people in academia [8]. Here we provide a sampling of conditions among individuals and available information on their roles in academic life. These vignettes also illustrate the hoped-for benefits of cultivating an academic environment that is more supportive of mental health.

Mood Disorders include depression, bipolar, and borderline personality. Depression involves persistent feelings of sadness and loss of interest. It can have numerous symptoms that may not be subjectively described as sadness, including feelings of hopelessness, guilt, shame, worthlessness, and a loss of interest in previously enjoyed things and activities. Some people may become more impulsive and aggressive during intense bouts of depression. Physical symptoms manifest as changes to eating, exercise, sleeping, and socialization routines (i.e., doing much more or much less of these activities) or unusual bodily pain such as headaches, and often exacerbate psychological symptoms. Episodes of depression can be

triggered by life events, large or small, and may last only a few days, or much longer. People with depression may not seek help because they see their problems as burdensome or not important enough to talk about. Supervisors and peers should encourage them to seek help.

Anxiety Disorders include generalized anxiety (described above), panic, and obsessive compulsive. Here we focus on Obsessive Compulsive (OCD). The international OCD Foundation describes obsessive compulsive disorder as follows: "In order for a diagnosis of obsessive compulsive disorder to be made, [a] cycle of obsessions and compulsions becomes so extreme that it consumes a lot of time and gets in the way of important activities that the person values…. Common obsession themes: contamination, religious obsessions (scrupulosity), fear of causing harm, symmetry/perfectionism, unwanted sexual thoughts". Manifestations will vary, but may include avoiding certain situations or locations.

Substance Use Disorders co-occur strongly with mood disorders [10]. The stresses of academic life offer many triggers for addictive behavior, which shares compulsive aspects but is distinct for involving pleasure-seeking behavior and denial of associated harm. The cultures of many academic disciplines can encourage heavy drinking [11]. In such environments, admitting to having trouble controlling one's drinking can be seen as a moral failure or professional lapse. Organizations should gather anonymized data on substance use and share it with members. Recent prohibitions against serving alcohol at conference poster and oral sessions at some geoscience meetings may be a first step to create more inclusive settings for non-drinkers and for those abstaining.

Bipolar disorder (f.k.a. manic-depressive disorder) comes in two primary types (I, and II). Each involves clear cyclic changes in mood, energy, and activity level—from periods in which an individual is extremely "up" or "high" (manic or hypomanic episodes) to periods in which an individual is extremely "down" (depressive episodes) and periods in which symptoms of both episodes are mixed together—but the frequency, duration, and severity differ. Individuals with bipolar disorder benefit from flexible schedules. Some use hypomanic periods to accomplish higher work output, and may choose to not treat symptoms due to positive feedback from these periods. Regular sleep cycles are essential for symptom maintenance, as work schedules not providing for adequate rest may trigger bipolar episodes. Scientists with collaborators who identify as bipolar should take extra care in setting work schedules.

Borderline Personality**:** Students living with the borderline personality disorder may need to terminate an otherwise successful term of study. Such students should have a supportive therapist and plan for the term in order to anticipate and work through upsetting events [9]. Improving support of mental health in the academic setting would reinforce such measures.

Schizophrenia: The story USC professor Elyn Saks demonstrates the possibility for some people living openly with schizophrenia to thrive in academia. Her experience being fired from an earlier position on grounds of negligence for not disclosing the condition also underscores the need for creating a culture where mental illness is not stigmatized, and where people are trained to spot signs of mental health crisis and to be supportive.

Autism Spectrum Disorder (ASD) is a group of developmental disabilities characterized by challenges with social interaction and communication, requiring different levels of support throughout education and employment. People with ASD are also more likely to experience depression [12] and suicidal ideation [13]. It is largely through material support from others that adults with ASD feel more comfortable in their jobs.

Reducing stigma around mental illness: Social stigma is a major impediment to seeking treatment from professionals or understanding from peers. The disclosure of mental illnesses often leads to negative interactions with peers, friends, family, employers and mentors, etc. A reduction in the impacts of mental illness thus could be accomplished by reducing stigma. Both education and contact with individuals with mental illness can reduce stigma [14].

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