**Schwarzschild Visualization**

**Scientific Virtual Reality Experience**

**Exhibition Proposal**

**Prepared November 2018 for ROM**

**Contact Information**

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**Executive Summary**

**Opportunity**

There is currently an unaddressed absence of VR exhibitions in museums. VR exhibits have a unique ability to engage visitors and create unique branding opportunities, as well as lasting experiences. This presents a chance to expose people to the sciences; more specifically, black holes and other phenomena that can be presented in a way that leverages existing VR technologies to make complex concepts digestible and fun. Following the success of an early few exhibits at forward-looking museums such as the National Museum of Natural History in Paris and the Smithsonian, in addition to audiences’ fascination with visuals from movies like Interstellar and Gravity, designing educational VR exhibits around astrophysics becomes an incredibly captivating idea.

**Objective**

The aim of this exhibition is to showcase dazzling interactive visual displays of Schwarzschild black holes utilizing the full capabilities of existing VR technologies. To accomplish this, we will develop an analytical mathematical framework and parallelized shader implementation to approximate the visual phenomena of **Schwarzschild black holes** in real time, including aberration, beaming, Doppler shift, Lorenz contraction, and other effects. The application will be powered by **Unity**, an industry-standard game engine used for projects spanning hobbyist demos to AAA consumer video games. In addition to the interactive VR experience, which will be the focal point of the exhibition, other projections and images designed to serve educational/explanatory purposes will also be included. User interfaces and training guides will be developed to ensure that the exhibit is easy to install/maintain stand-alone, and suitable for most ages.

**Team**

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| **Lucas Schuermann** | Lucas currently works as the CTO/founder of a quantitative hedge fund and a consultant for early-stage start-ups on engineering and machine learning. He was previously an Egleston Research Scholar at Columbia University's School of Engineering and Applied Science in New York, NY studying Computer Science. He has recently worked as an NSF fellow in the Columbia Computer Graphics Group, a summer researcher at Wolfram, an undergraduate researcher in Columbia's Bionet Lab, at Goldman Sachs as a quantitative strategist, and on machine learning for robotics at Google X. Lucas has extensive experience in computer graphics research, having begun work on smoothed particle hydrodynamics simulations at age 12, and having designed lecture material for Columbia’s class on the subject as the only undergraduate teaching assistant. For more about Lucas, please visit <http://lvs.io/about>. |
| **Windsor Huang** | Windsor is a freshman at the University of Toronto studying Computer Science and Statistics. He is an experienced artist and software developer who hopes to combine his two passions in the creation of this project. Windsor will build the wireframe/diagrammed flow of the different user interface interactions, story elements (3D assets) for the interactive VR portion of this exhibition and integrate Lucas’ mathematical shader implementations into Unity. For more about Windsor, please visit http://windsorhuang.com. |

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| **TIMELINE** | | |
| **PHASE** | **TASK** | **START & END DATES** |
| Planning | * Finalizing necessary documentation for the planning and timeline of this exhibit | Present |
| Development | * Work on 3d proof of concept with basic renderer * Get early user feedback, figure out what elements to prioritize for beta * Hire graphics designers/3d modelers/etc to build out any particular assets (e.g. interface/logo/models of planets) * Iteratively work towards final 3d system * Continuously test with ROM with a focus on maintainability and user comfort | December – January |
| Finalization | * Work with ROM to figure out constraints on deployment * Secure museum for exhibition * Secure sponsorship for headsets donation | January- March |
| Release | * Work with ROM to develop marketing plan * Trial and demo exhibit to train ROM staff/volunteers * Unveil! | March – April |

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| **PROJECT BUDGET / COST OVERVIEW** | |
| 1. VR development workstation computer ~ $1500 - $2000 2. Oculus Rift + Touch virtual reality system ~ $500-600 3. Professional graphics and logo design + music production ~ $1000 4. Peripherals/miscellaneous development expenses ~ $500 5. Museum set-up ~ Estimated per-unit cost (tentative) of ~$1000-2000 | |
| **GRAND TOTAL** | $3000 - $4100 |

**Notes:**