

## Habilitation thesis reviewer's report

<b>Masaryk University</b>	
<b>Faculty</b>	Faculty of Science
<b>Field of study</b>	Theoretical Physics and Astrophysics
<b>Applicant</b>	<i>Norbert Werner, PhD</i>
<b>Affiliation</b>	Stanford University
<b>Habilitation thesis (title)</b>	<i>From supermassive black holes to the large-scale structure of the Universe.</i>
<b>Reviewer</b>	Craig L. Sarazin, B.S. Physics California Inst. of Tech., M.A., Ph.D. Physics, Princeton University
<b>Affiliation</b>	W. H. Vanderbilt Professor of Astronomy, University of Virginia

### Reviewer's report (extent of text up to the reviewer)

This thesis represents a tremendous body of work. Of the nine research chapters, eight are refereed published papers in the most highly regarded journals in astrophysics, *Monthly Notices of the Royal Astronomical Society* and the *Astrophysical Journal*. One is a *Nature* paper. In each case, Norbert is the first author. These nine (relatively recent) papers have already been cited more than 220 times.

The Introduction gives a nice overview of the subject, and clearly presents the key questions Norbert is addressing. The final chapter gives a good summary, and describes some of Norbert's plans for the future. The English is perfect, and in general the writing style is absolutely excellent. It is much better than I would expect from our graduates students, most of whom are native English speakers.

Norbert is generally regarded as one of the best young astronomers working in X-ray astronomy and in galaxies and clusters of galaxies. His work on the outskirts of galaxy clusters, on abundance distributions in clusters, on AGN feedback, and on resonance line scattering and turbulence in clusters has been particularly influential. He has been tremendously productive. He has produced about 70 referred papers that have generated about 1900 citations.

Norbert will be a tremendous asset to your university. In addition to his scientific output, given Norbert's knowledge, great abilities, and age, I would expect him to play a major role in the development of Athena, ESA's approved L-class X-ray observatory.

I know that in many countries, the Habilitation also has a large educational component. In this regard, I might mention that Norbert gives excellent, clear scientific talks. (The materials in Chapters 1 and 11 also show his flair for presenting material to non-specialist in a very understandable and exciting way.) I expect that Norbert will be an excellent and very popular teacher.

### Reviewer's questions for the habilitation thesis defense

What do you think are the next crucial steps in addressing the two over-arching questions raised in this thesis?

1. How do black holes regulate the growth of structure?
2. How did the star formation and chemical enrichment of the Universe proceed?

What are your plans for the immediate future in these areas?

To what extent will your plans be impeded by the recent failure of the Hitomi satellite?

### Conclusion

The habilitation thesis submitted by Norbert Werner entitled *From Supermassive Black Holes to the Large-Scale Structure of the Universe* meets the requirements applicable to habilitation theses in the field of theoretical physics and astrophysics.

  
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