

# <sup>1</sup> cosmo-numba: B-modes and COSEBIs computations accelerated by Numba

<sup>3</sup> Axel Guinot  <sup>1</sup> and Rachel Mandelbaum 

<sup>4</sup> 1 Department of Physics, McWilliams Center for Cosmology, Carnegie Mellon University, Pittsburgh, PA  
<sup>5</sup> 15213, USA

DOI: [10.xxxxxx/draft](https://doi.org/10.xxxxxx/draft)

## Software

- <sup>6</sup> [Review](#) 
- <sup>7</sup> [Repository](#) 
- <sup>8</sup> [Archive](#) 

Editor: [Open Journals](#) 

Reviewers:

- <sup>9</sup> [@openjournals](#)

Submitted: 01 January 1970

Published: unpublished

## License

Authors of papers retain copyright and release the work under a  
<sup>10</sup> Creative Commons Attribution 4.0 International License ([CC BY 4.0](#)).  
<sup>11</sup> Cosmo-numba facilitate the computation of E-/B-modes decomposition using two methods. One  
<sup>12</sup> of them is the Complete Orthogonal Sets of E-/B-mode Integrals (COSEBIs) as presented in  
<sup>13</sup> P. Schneider et al. (2010). The COSEBIs rely on very high precision computation requiring  
<sup>14</sup> more than 80 decimal numbers. P. Schneider et al. (2010) propose an implementation  
<sup>15</sup> using mathematica. cosmo-numba make use of combination of sympy and mpmath to reach the  
<sup>16</sup> required precision. This python version enable an easier integration in cosmology pipeline and  
<sup>17</sup> facilitate the null tests.

<sup>18</sup> This software package also include the computation of the pure-mode correlation functions  
<sup>19</sup> presented in Peter Schneider et al. (2022). Those integrals have less constraints than the  
<sup>20</sup> COSEBIs but having a fast computation is necessary to computing the covariance matrix. One  
<sup>21</sup> can also include use those correlation function for cosmological inference in which case the  
<sup>22</sup> multiple call to the likelihood will also require a fast implementation.

## <sup>23</sup> COSEBIs

<sup>24</sup> The COSEBIs are defined as:

$$E = \frac{1}{2} \int 0 \infty d\theta [T_+(\theta) \xi_+(\theta) + T_-(\theta) \xi_-(\theta)] \quad (1)$$

## <sup>25</sup> Mathematics

<sup>26</sup> Single dollars (\$) are required for inline mathematics e.g.  $f(x) = e^{\pi/x}$

<sup>27</sup> Double dollars make self-standing equations:

$$\Theta(x) = \begin{cases} 0 & \text{if } x < 0 \\ 1 & \text{else} \end{cases}$$

<sup>27</sup> You can also use plain L<sup>A</sup>T<sub>E</sub>X for equations

$$\hat{f}(\omega) = \int_{-\infty}^{\infty} f(x)e^{i\omega x}dx \quad (2)$$

<sup>28</sup> and refer to [Equation 2](#) from text.

## <sup>29</sup> Citations

<sup>30</sup> Citations to entries in paper.bib should be in [rMarkdown](#) format.

<sup>31</sup> If you want to cite a software repository URL (e.g. something on GitHub without a preferred  
<sup>32</sup> citation) then you can do it with the example BibTeX entry below for (?).

<sup>33</sup> For a quick reference, the following citation commands can be used: - @author:2001 ->  
<sup>34</sup> “Author et al. (2001)” - [@author:2001] -> “(Author et al., 2001)” - [@author1:2001;  
<sup>35</sup> @author2:2001] -> “(Author1 et al., 2001; Author2 et al., 2002)”

## <sup>36</sup> Figures

<sup>37</sup> Figures can be included like this: Caption for example figure. and referenced from text using  
<sup>38</sup> [section](#).

<sup>39</sup> Figure sizes can be customized by adding an optional second parameter: Caption for example  
<sup>40</sup> figure.

## <sup>41</sup> Acknowledgements

<sup>42</sup> We acknowledge contributions from Brigitta Sipocz, Syrtis Major, and Semyeong Oh, and  
<sup>43</sup> support from Kathryn Johnston during the genesis of this project.

## <sup>44</sup> References

<sup>45</sup> Schneider, Peter, Asgari, M., Jozani, Y. N., Dvornik, A., Giblin, B., Harnois-Déraps, J.,  
<sup>46</sup> Heymans, C., Hildebrandt, H., Hoekstra, H., Kuijken, K., Shan, H., Tröster, T., & Wright,  
<sup>47</sup> A. H. (2022). Pure-mode correlation functions for cosmic shear and application to KiDS-  
<sup>48</sup> 1000. *Astronomy & Astrophysics*, 664, A77. <https://doi.org/10.1051/0004-6361/202142479>

<sup>50</sup> Schneider, P., Eifler, T., & Krause, E. (2010). COSEBIs: Extracting the full e-/b-mode  
<sup>51</sup> information from cosmic shear correlation functions. *Astronomy and Astrophysics*, 520,  
<sup>52</sup> A116. <https://doi.org/10.1051/0004-6361/201014235>