

A WEIGHTED GENERALISATION OF CARLEMAN'S INEQUALITY

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Abstract. In this paper, we present a generalisation of the classical inequality of Carleman, which we obtain by an elementary argument based on log-convexity and Hölder's inequality. As a consequence, we recover some other classical estimates such as the Pólya-Knopp inequality.

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REFERENCES

- [1] G. BENNETT, *Factorizing the classical inequalities*, Mem. Amer. Math. Soc. **120** (1996), no. 576, viii+130.
- [2] C. BENNETT AND R. SHARPLEY, *Interpolation of operators*, Pure and Applied Mathematics, vol. 129, Academic Press, Inc., Boston, MA, 1988.
- [3] R. P. BOAS, JR., *Some integral inequalities related to Hardy's inequality*, J. Analyse Math. **23**, (1970), 53–63.
- [4] T. CARLEMAN, *Sur les fonctions quasi-analytiques*, Fifth Scand. Math. Congress (1923).
- [5] L. CARLESON, *A proof of an inequality of Carleman*, Proc. Amer. Math. Soc. **5** (1954), 932–933.
- [6] M. J. CARRO AND J. SORIA, *Weighted Lorentz spaces and the Hardy operator*, J. Funct. Anal. **112** (1993), no. 2, 480–494.
- [7] C.-P. CHEN AND R. B. PARIS, *An inequality involving the constant e and a generalized Carleman-type inequality*, Math. Inequal. Appl. **23** (2020), no. 4, 1197–1203.
- [8] J. A. COCHRAN AND C. S. LEE, *Inequalities related to Hardy's and Heinig's*, Math. Proc. Cambridge Philos. Soc. **96** (1984), no. 1, 1–7.
- [9] A. ČIŽMEŠIJA AND J. PEČARIĆ, *Some new generalisations of inequalities of Hardy and Levin-Cochran-Lee*, Bull. Austral. Math. Soc. **63** (2001), no. 1, 105–113.
- [10] A. ČIŽMEŠIJA, S. HUSSAIN AND J. PEČARIĆ, *Some new refinements of strengthened Hardy and Pólya-Knopp's inequalities*, J. Funct. Spaces Appl. **7** (2009), no. 2, 167–186.
- [11] A. ČIŽMEŠIJA, J. PEČARIĆ AND L.-E. PERSSON, *On strengthened Hardy and Pólya-Knopp's inequalities*, J. Approx. Theory **125** (2003), no. 1, 74–84.
- [12] G. H. HARDY, *Notes on some points in the integral calculus LX*, Messenger of Math. **54** (1925), 150–156.
- [13] H. P. HEINIG, *Some extensions of Hardy's inequality*, SIAM J. Math. Anal. **6** (1975), 698–713.
- [14] M. JOHANSSON, L.-E. PERSSON AND A. WEDESTIG, *Carleman's inequality-history, proofs and some new generalizations*, JIPAM. J. Inequal. Pure Appl. Math. **4** (2003), no. 3, Article 53, 19.
- [15] S. KAIJSER, L.-E. PERSSON AND A. ÖBERG, *On Carleman and Knopp's inequalities*, J. Approx. Theory **117** (2002), no. 1, 140–151.
- [16] K. KNOPP, *Über Reihen Mit Positiven Gliedern*, J. London Math. Soc. **3** (1928), no. 3, 205–211.
- [17] E. R. LOVE, *Inequalities related to those of Hardy and of Cochran and Lee*, Math. Proc. Cambridge Philos. Soc. **99** (1986), no. 3, 395–408.
- [18] E. R. LOVE, *Inequalities related to Carleman's inequality*, Inequalities (Birmingham, 1987), Lecture Notes in Pure and Appl. Math., vol. 129, Dekker, New York, 1991, pp. 135–141.
- [19] D.-C. LUOR, *On weighted inequalities with geometric mean operator*, Bull. Aust. Math. Soc. **78** (2008), no. 3, 463–475.
- [20] D.-C. LUOR, *Modular inequalities for the Hardy-Littlewood averages*, Math. Inequal. Appl. **13** (2010), no. 3, 635–642.

- [21] B. OPIC AND P. GURKA, *Weighted inequalities for geometric means*, Proc. Amer. Math. Soc. **120** (1994), no. 3, 771–779.
- [22] L. PICK AND B. OPIC, *On the geometric mean operator*, J. Math. Anal. Appl. **183** (1994), no. 3, 652–662.