Necessary conditions for a norm estimate of Riesz potential on Morrey spaces over hypergroups

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Necessary Conditions for a Norm Estimate of Riesz Potential on Morrey Spaces over Hypergroups

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Abstract. Necessary conditions for a norm estimate of Riesz potential will be presented on Morrey spaces over commutative hypergroups by taking into account the upper Ahlfors condition. This norm estimate is the Hedberg type estimate. By assuming that the weak estimate of maximal operator holds in Morrey spaces over commutative hypergroups, the Hedberg type estimate leads to the weak estimate of the Riesz potential.

INTRODUCTION

Some estimates regarding Riesz potential, which is also known as fractional integral operator, have been known for many types of spaces. The well-known results on strong and weak type estimates for Riesz potential on Lebesgue spaces over Euclidean spaces were provided by Hardy and Littlewood [1] as well as Sobolev [2]. These results were then extended by Petree in Spanne [3], Adams [4], as well as Chiarenza and Frasca [5] into Morrey spaces over Euclidean spaces; and by Nakai [6] as well as Guliyev [7] into generalized Morrey spaces over Euclidean spaces. After Nazarov *et. al* [8] introduced the notion of non-doubling measure, some estimates on Riesz potential were then established on Lebesgue, Morrey, and generalized Morrey spaces over Euclidean spaces with non-doubling measure. (See [9, 10, 11, 12] and some other references.) Later, the estimates of fractional integral operators on Lebesgue spaces, Morrey spaces and their generalization over metric spaces were given under doubling as well as non-doubling measure. These can be seen for example in [13, 14, 15, 16, 17]. The estimates can be proved using several norm estimates. One of them is introduced by Hedberg [18] so that some researchers call such norm estimate as Hedberg estimate. Recently, on commutative hypergroups $(K; *)$ which possess a Haar measure μ, Hajibayov [19] defined the Riesz potential I_α to be

$$I_\alpha f(x) := \int_K \rho(e,r)^{\alpha-n} T^x f(y^*)\, d\mu(y)\,.$$

Here, T^x (for $x \in K$) denotes the generalized translation operator and is given by

$$T^x f(y^*) = \int_K f\, d(\delta_x * \delta_y), \quad \text{for every } y \in K,$$

where δx and δy denote probability measures for x and y respectively. Hajibayov proved that the Riesz potential satisfied the norm estimates, i.e. the strong and weak estimates, for $1 \le p \le q < 1$ on Lebesgue spaces over commutative hypergroup under the condition of upper Ahlfors n-regular by an identity. This condition says that there exists a positive constant C (which is independent of $r > 0$) such that

$$\mu\big(B(e,r)\big) \le Cr^n.$$

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Here the ball $B(e, r)$ has center e (that is the identity of the hypergroup $(K; *)$) and radius r. Note that in this paper, we will denote C as the positive constants which have different values. The results in [19] assume that the maximal operator

$$Mf(x) = \sup_{r>0} \frac{1}{\mu(B(e,r))} \int_{B(e,r)} T^x |f(y^*)| \, d\mu(y) \, .$$

satisfies strong and weak estimates. As it is described previously that the results on Lebesgue spaces can be extended into Morrey spaces, our aim in this paper is then to extend the Hedberg estimate into Morrey spaces over commutative hypergroup; and we will use this Hedberg type estimate to prove the weak estimate of the Riesz potential in the space under consideration. For $1 \leq p \leq q < 1$, Morrey spaces $\mathfrak{M}^{p,q}(K, \mu)$ consist of all μ-measurable functions $f: K \to (-\infty, \infty)$ such that the norm

$$\|f\|_{\mathfrak{W}^{p,q}(K,\mu)} := \sup_{B=B(e,r)} \mu(B)^{\frac{1}{q}-\frac{1}{p}} \left(\int_B |f(x)|^p \, d\mu(x) \right)^{\frac{1}{p}}$$

is finite.

MAIN RESULTS

The Hedberg tipe estimate will be stated in the following theorem.

Theorem 1. *Let* $1 < q < \infty, 1 < s < \infty, \ 0 < \alpha < \frac{\alpha}{q}$, *and the measure* μ *satiesfies the condition of upper Ahlfors n-regular by an identity.* If $\frac{1}{s} = 1 - \frac{\alpha}{n}$, *then there is a positive constant C such that the norm estimate*

$$|I_\alpha f(x)| \leq CMf(x)^{\frac{q}{s}} \|f\|^{\frac{\alpha q}{n}}_{\mathfrak{W}^{1,q}(K,\mu)}$$

holds.

Proof. For every f in $\mathfrak{W}^{1,q}(K, \mu)$, we write

$$I_\alpha f(x) = U_1 + U_2$$

where

$$U_1 = \int_{B(e,r)} \rho(e,r)^{\alpha-n} T^x f(y^*) \, d\mu(y)$$

and

$$U_2 = \int_{K \setminus B(e,r)} \rho(e,r)^{\alpha-n} T^x f(y^*) \, d\mu(y).$$

Firstly, we find the estimate for U_1 , which is given by

$$\begin{aligned} |U_1| &\leq \int_{B(e,r)} \rho(e,r)^{\alpha-n} T^x |f(y^*)| d\mu(y) \\ &\leq \sum_{j=1}^{\infty} \frac{1}{(2^{-j}r)^{n-\alpha}} \int_{B(e,2^{-j+1}r)} |f(y^*)| d\mu(y) \\ &\leq Cr^\alpha Mf(x). \end{aligned}$$

Next, we find the estimate for U_2, that is

$$\begin{aligned} |U_2| &\leq \int_{K \setminus B(e,r)} \rho(e,r)^{\alpha-n} |T^x f(y^*)| \, d\mu(y) \\ &\leq \sum_{j=0}^{\infty} \frac{1}{(2^j r)^{n-\alpha}} \int_{B(e,2^{j+1}r)} |T^x f(y^*)| d\mu(y) \\ &\leq Cr^{\alpha-\frac{n}{q}} \|f\|_{\mathfrak{W}^{1,q}(K,\mu)}. \end{aligned}$$

By taking

$$r = \left(\frac{Mf(x)}{\|f\|_{\mathfrak{W}^{1,q}(K,\mu)}} \right)^{-\frac{q}{n}},$$

the following result

$$|I_\alpha f(x)| \le C\left(r^\alpha Mf(x) + r^{\alpha-\frac{n}{q}}\|f\|_{\mathfrak{W}^{1.q}(K,\mu)}\right) = CMf(x)^{\frac{q}{s}}\|f\|^{\frac{\alpha q}{n}}_{\mathfrak{W}^{1.q}(K,\mu)}$$

follows. ■

The Hedberg type estimate then give us the following theorem.

Theorem 2. *Let* $1 < q < \infty, 1 < s < \infty,$ *and* $0 < \alpha < \frac{n}{q}$. *Assume taht the measure* μ *satisfies the condition of upper Ahlfors n-regular by an identity. Assume also that there is a positive constant* C_1 *such that the naximal operator M satisfies the weak estimate*

$$\mu(\{x \in B(e,r): Mf(x) > \lambda_1\}) \le \frac{C_1 r^{n\left(1-\frac{1}{q}\right)}}{\lambda_1}\|f\|_{\mathfrak{W}^{1.q}(K,\mu)}.$$

If $\frac{1}{s} = \frac{1}{p} - \frac{\alpha}{n}$, *then there exists a positive constant C such that*

$$\mu(\{x \in B(e,r): I_\alpha f(x) > \lambda\}) \le Cr^{n\left(1-\frac{1}{q}\right)}\left(\frac{\|f\|_{\mathfrak{W}^{1.q}(K,\mu)}}{\lambda}\right)^{\frac{s}{q}}$$

holds for any positive μ*-measurable function f.*

Proof. From the Hedberg type estimate in Theorem 1, for $|I_\alpha f(x)| > \lambda,$ we have

$$Mf(x) > \left(\frac{\lambda}{\|f\|^{\frac{\alpha q}{n}}_{\mathfrak{W}^{1.q}(K,\mu)}}\right)^{\frac{s}{q}}.$$

This last equation and the estimate of the maximal operator then provide us with

$$\begin{aligned}\mu(\{x \in B(e,r): I_\alpha f(x) > \lambda\}) &\le \mu\left(\left\{x \in B(e,r): Mf(x) > \left(\frac{\lambda}{\|f\|^{\frac{\alpha q}{n}}_{\mathfrak{W}^{1.q}(K,\mu)}}\right)^{\frac{s}{q}}\right\}\right)\\ &\le \frac{Cr^{n\left(1-\frac{1}{q}\right)}\|f\|_{\mathfrak{W}^{1.q}(K,\mu)}}{\left(\frac{\lambda}{\|f\|^{\frac{\alpha q}{n}}_{\mathfrak{W}^{1.q}(K,\mu)}}\right)^{\frac{s}{q}}}\\ &= Cr^{n\left(1-\frac{1}{q}\right)}\left(\frac{\|f\|_{\mathfrak{W}^{1.q}(K,\mu)}}{\lambda}\right)^{\frac{s}{q}}.\end{aligned}$$

Thus, the desired estimate is proved. ■

CONCLUSION

Here we apply the Hedberg type estimate to find the weak type estimate for Riesz potential. However, we may prove the weak estimate without Hedberg type estimate if we have no assumption on maximal operator.

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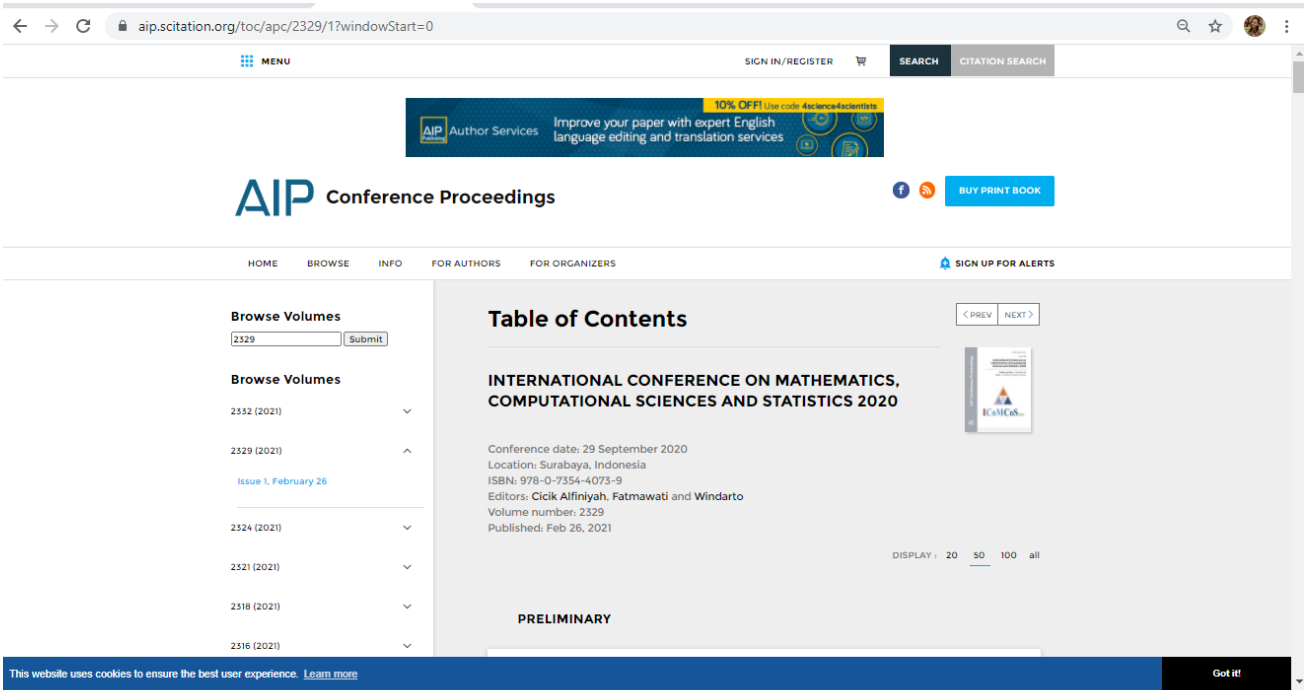

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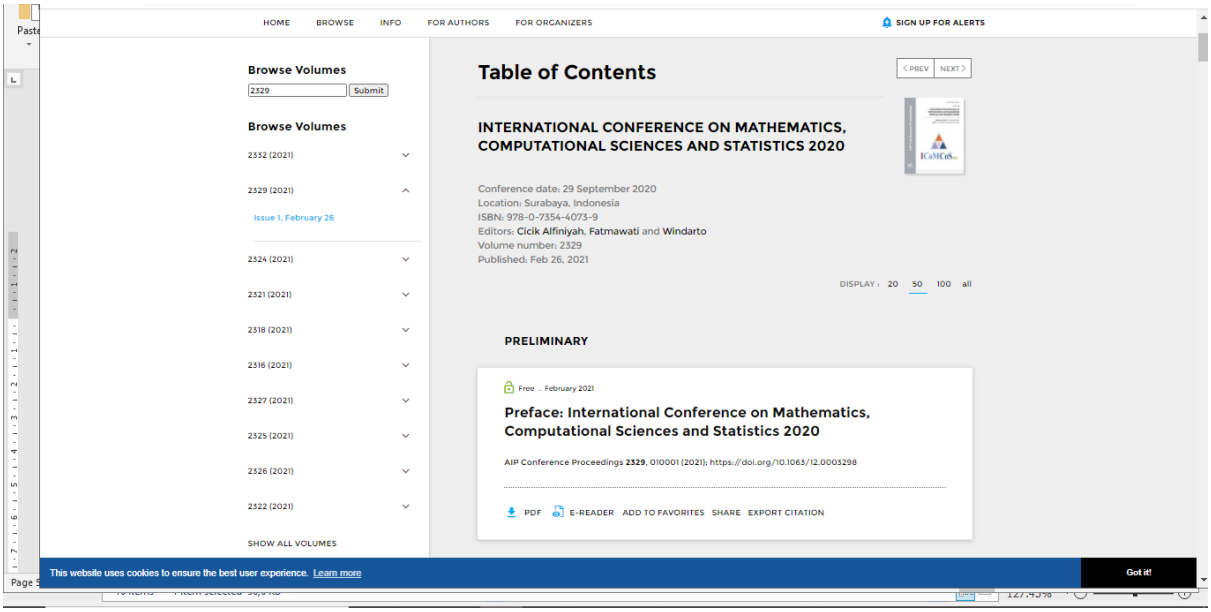
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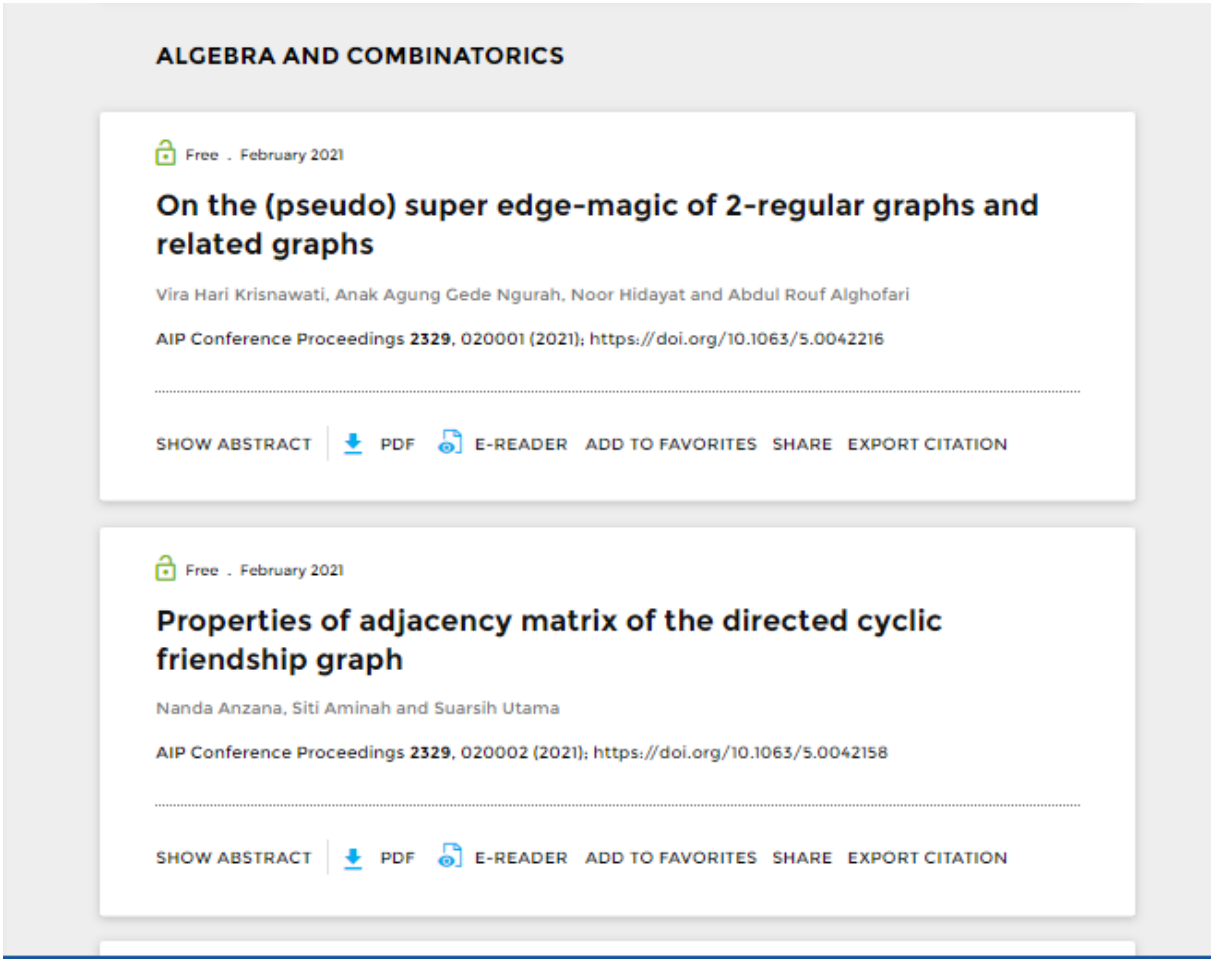
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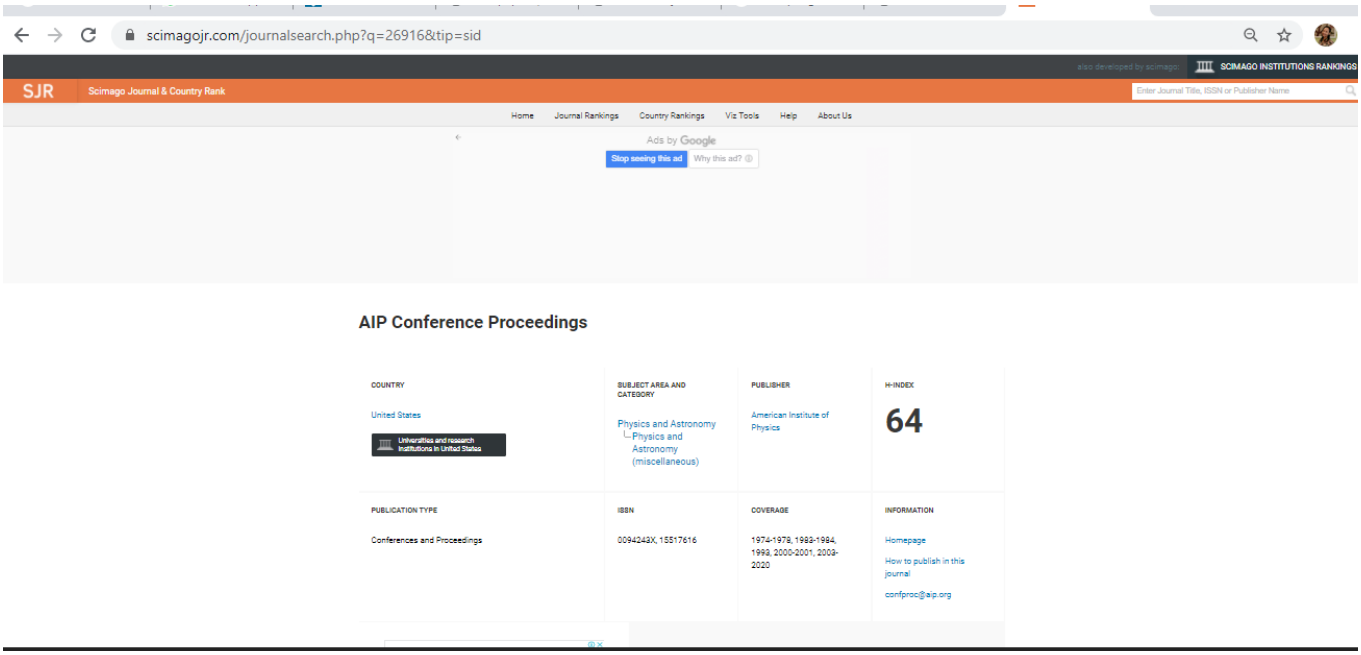

Transformation Method for Solving Interval Linear Programming Problem

Herry Suprajitno[1,a)] and Ismail bin Mohd[2]

[1]*Faculty of Sciences Technology, Universitas Airlangga, Indonesia*
[2]*Universiti Malaysia Perlis, Malaysia*

[a)]Corresponding author: herry-s@fst.unair.ac.id

Abstract. Linear programming model has been successfully implemented in various fields such as industrial manufacturers, agriculture, transportation, medical and military. But in many cases in reality, parameter values of in the model could not be determined precisely. Therefore, the parameters might be estimated using an interval. In this paper, interval linear programming problem (linear programming problem with parameters / coefficients and decision variables in the form of interval) is discussed. The interval linear programming problem is transformed into linear programming problem.

BUKTI CONVERSATION

ICoMCoS 2020 submission 56 Inbox

ICoMCoS... 24/07/2020

to me

Dear authors,

We received your submission to ICoMCoS 2020 (International Conference on Mathematics, Computer Sciences and Statistics):

Authors : Idha Sihwaningrum, Ari Wardayani and Sri Maryani
Title : Necessary conditions for a norm estimate of Riesz potential on Morrey spaces over hypergroups
Number : 56

The submission was uploaded by Idha Sihwaningrum <idha.sihwaningrum@unsoed.ac.id>. You can access it via the ICoMCoS 2020 EasyChair Web page

https://easychair.org/conferences/?conf=icomcos2020

Thank you for submitting to ICoMCoS 2020.

Best regards,
EasyChair for ICoMCoS 2020.

Reply | Reply all | Forward

Letter of Acceptance

Inbox

ICoMCoS... 15/08/2020
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Dear I Sihwaningrum, A Wardayani, and Sri Maryani,

We are delighted to inform that your paper **has been accepted with minor correction** for publication in the *International Conference on Mathematics, Computational Science and Statistics 2020 Proceeding* indexed by Scopus.

Besides the letter of acceptance, the review forms (as well as comments) from reviewers can be found in the attachment of this email. You are requested to kindly revise your manuscript according to the comments (please notice that there is more than one reviewer), then please submit it to our email or update on Easy Chair **before August 22, 2020**.

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Best Regards,

ICoMCoS 2020 Organizing

ICoMCoS 2020
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Computational Sciences and Statistics 2020
Department of Mathematics
Faculty of Science and Technology
Universitas Airlangga, Surabaya/Indonesia

ACCEPTANCE LETTER

Dear **I Sihwaningrum**,

On behalf of the Scientific Committee, we are pleased to inform you that your paper :

Paper ID	: AG02
Authors	: I Sihwaningrum, A Wardayani, and Sri Maryani
Paper Title	: Necessary conditions for a norm estimate of Riesz potential on Morrey spaces over hypergroups

has been accepted with minor correction for publication in the *International Conference on Mathematics, Computational Science and Statistics (ICoMCoS) 2020* Proceeding indexed by Scopus.

The review forms explaining the status of your manuscript and comments from reviewers can be found in the attachment. You are requested to kindly revise your manuscript according to the comments, then submit it, before August 22, 2020.
Please kindly notice that **only papers submitted and presented at the conference** will be published in the conference proceeding. We look forward to meeting you on September 29, 2020.

Yours sincerely,

Cicik Alfiniyah, PhD
Chairman of the Organizing Committee

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Department of Mathematics
Faculty of Science and Technology
Airlangga University, Surabaya/Indonesia

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In this article, authors present necessary condition for a Hedberg type norm estimate of Riesz potential on Morrey spaces over commutative hypergroups with assumption that the weak estimate of maximal operator holds.

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ICoMCoS 2020

Paper Code	AG02
Paper Title	: Necessary conditions for a norm estimate of Riesz potential on Morrey spaces over hypergroups
Presenter Name	Idha Sihwaningrum
E-mail	idha.sihwaningrum@unsoed.ac.id
Mobile Phone Number	(+62) 8122759820

ICoMCoS 2020
International Conference on Mathematics Computational Sciences and Statistics 2020
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Universitas Airlangga, Surabaya/Indonesia

INVITATION LETTER

Paper ID : AG02

Dear **I Sihwaningrum, A Wardayani, and Sri Maryani**,

We are delighted to inform you that your paper entitled "Necessary conditions for a norm estimate of Riesz potential on Morrey spaces over hypergroups" has been accepted for publication in the *International Conference on Mathematics, Computational Science and Statistics (ICoMCoS) 2020* Proceeding indexed by Scopus. Therefore, we would like to invite the presenter of your paper to join our online conference :

Day/Date	: Tuesday, September 29, 2020
Time	: 8 A.M - end
Venue	: Zoom Webinar

The invitation link also the schedule for the parallel session will be published later through Whatsapp group. We highly recommend that **the presenter** can join the Whatsapp group immediately for further details about the conference : https://chat.whatsapp.com/FMRsJZ1khOP1CS7WQJhxDW and fill this form : http://bit.ly/ICoMCoS_2020. Please kindly be reminded that the deadline for the camera ready paper is on October 10, 2020.

Yours sincerely,

Cicik Alfiniyah, PhD
Chairman of the Organizing Committee